

Supreme Court of the United States
OCTOBER TERM, 1942

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MARCONI WIRELESS TELEGRAPH COMPANY OF
AMERICA, PETITIONER.

15.

THE UNITED STATES

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15.

MARCONI WIRELESS TELEGRAPH COMPANY OF
AMERICA

ON WRITS OF HABEAS CORPUS TO THE COURT OF CLAIMS

PETITIONS FOR CERTIORARI FILED SEPTEMBER 2, 1942.
SEPTEMBER 3, 1942.

CERTIORARI GRANTED DECEMBER 14, 1942.

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1942

No. 369

MARCONI WIRELESS TELEGRAPH COMPANY OF
AMERICA, PETITIONER,

vs.

THE UNITED STATES

No. 373

THE UNITED STATES, PETITIONER,

vs.

MARCONI WIRELESS TELEGRAPH COMPANY OF
AMERICA

ON PETITIONS FOR WRITS OF CERTIORARI TO THE COURT OF CLAIMS

VOL. II

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JUDD & DETWEILER (I. C.), PRINTERS, WASHINGTON, D. C., SEPT. 18, 1942.

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He next showed that by impressing on this system a simple harmonic force, the mathematical expression for the current consisted of two components, one of which corresponded to the harmonic force impressed, and the second was the free or natural vibration, which he stated was soon suppressed or could be easily removed, and therefore we had to consider merely the first. He showed that by making the angular velocity equal to one over the square root of CL , capacity and inductance, a condition of resonance resulted which was first noted by Grove in 1868, who supplied an alternating current to a Ruhmkorff coil and noticed sparks in the secondary circuit, which he considered of sufficient importance to communicate to Maxwell.

He then related what he had accomplished, and stated that he impressed an alternating current on a resonant circuit, and showed what the apparent resistance was and the apparent impedance of that secondary circuit. He stated that two frequencies actually resulted which were in proximity as to frequency, but that the higher one was made still higher and the lower one made still lower. He again pointed out that this was analogous to acoustical arrangements and that the vibratory condition was known as the linear theory; that inductance and capacity are really independent of the frequency, that the resistance was independent of the current and that they were constant.

He pointed out also that the wave form was distorted by the presence of iron, and in this connection referred us to the *Physical Review*, about 1898, he said we should use coils without iron and condensers without dielectric capacity.

The second lecture—

Question. Before you go to that, Mr. Dean, I will ask you to just refer to those parts of your notes in regard to Mr. Stone talking of his own work to you before you leave that first lecture. Speak of the parts that referred to those different elements of his talk, so that we can identify them in the notes themselves. When you take up those different notes, starting with Stone's description of his own work, point out what part of the notes refer to these different things you speak of, and then follow that same thing when you get down to the second lecture. It occurs to me that we will be going over this thing twice unless you do that.

[fol. 682] Answer. I stated with respect to the first lecture that Professor Stone said, "I impress an alternating current," etc., which I believe is what you wish.

Mr. Knight: If you have notes that enable you to refer to any one of these things, I want you to point out the part of the notes you are speaking of.

Answer (continuing). Yes. In the second lecture we considered again two resonant circuits in proximity, inductively coupled, each having variable capacity and variable inductance. Mathematical expressions were given to show that the summation of the inductive voltage, resistance voltage, capacity voltage, and mutual induction voltage must be equal to zero.

Then follows a lengthy mathematical discourse, showing the properties of resonant circuits.

He then showed us how to obtain oscillatory vibrations of very small wave lengths and drew two diagrams of such circuits inductively coupled to secondary circuits. He showed how Hertz got continuous vibrations with a rotary gap or interrupter in the primary, and a condenser and an oscillation transformer, which transferred the energy to the oscillatory circuit. He stated that Hertz got several hundred million vibrations per second by using very low inductance and capacity, and drew a diagram showing the Hertz oscillator.

He also referred to Tesla's experiments along this line and drew two diagrams showing the three-circuit arrangement employed by Tesla.

He next referred to Marconi's experiments, the diagram of which appears to be similar to that of Hertz, with one oscillator in the air, and assuming the earth to connect to the spark gap which was in the aerial circuit.

He showed what had been accomplished by the post-office experiments in England, by transmission of signals between parallel wires and with horizontal loops, which depended upon induction.

He showed us Marconi's receiving circuits, with the coherer shunted around the spark gap in the aerial circuit. He then described the coherer and its inherent limitations.

The remainder of this lecture appears to be the practical applications, and he first showed us how multiplex line telegraphy could be accomplished, making use of electrical resonance, and drew diagrams showing several sending stations, or circuits, each containing a key, variable capacity and inductance, and each operating at a different known frequency. The corresponding receiving stations were similar, except that a relay was used in place of the key. Each

receiving circuit was tuned respectively to its sending circuit. He again called our attention to the necessity for these resonant circuits to have simple wave forms, although of different frequency.

He then proceeded to show that in place of the telegraph a modification of this application would be to use telephones in closed circuits, also with variable capacity and inductance, but inductively connected to the line. Similar arrangements were used at the receiving end. In this case also the sending circuit and its respective receiving circuit were tuned to the same wave lengths.

The hour period being nearly up, he briefly referred to the next logical application, namely, to wireless. He then [fol. 683] called our attention to an article in the proceedings of the American Institute of Electrical Engineers, about 1899, relative to the question of tuning wireless circuits, and referred in particular to Pupin's articles on condenser-coupled circuits. That is the end of the course.

• • • • • • •

8. Question. Please state whether you afterwards constructed or put into operation a wireless telegraph system.

Answer. Yes, sir; at the Norfolk Navy Yard.

9. Question. Please state whether preliminary thereto you had any instruction to enable you to do so, other than that gained from this lecture by Professor Stone and the other lectures preliminary thereto, referred to?

Answer. I installed one of the first wireless telegraph sets of the Navy Department, namely, a Bucquet set of instruments, I believe in 1903, at the Norfolk station, in which I had for guidance merely the catalogue which accompanied these instruments, and which was written in French, and which was in itself hardly sufficient to make a complete installation. I believe that my instruction obtained at the Massachusetts Institute made it possible for me to put that station into successful operation.

Mr. Knight: I would like to offer these notes in evidence.

(Marked "Defendant's Exhibit F-3A.")

10. Question. You made these notes yourself at the time of these lectures in January, 1900?

Answer. Yes, sir; 1900, in my own handwriting.

11. Question. While the lecture was being given?

Answer. Yes, sir.

Cross-examination.

By Mr. Betts:

12. Cross-question. The notes that you have produced are not themselves dated, are they?

Answer. No, sir. It was a very easy — to establish the date, however, for the reason that these lectures followed immediately after Professor Clifford's lectures in theoretical electricity, and they invariably occupied the first semester of the senior year.

13. Cross-question. Have you been detailed by the Navy Department to appear here and testify in this case?

Answer. No, sir.

14. Cross-question. Is there any illustration in the notes which you have produced of an open circuit coupled to a closed circuit as used in radio telegraphy?

[fol. 684] Answer. Yes.

15. Cross-question. Where?

Answer. I have two diagrams, adjoining the words "For oscillatory vibrations for a very small length of time," in which power appears to be taken from a battery, the conventional way of showing power, and a key and an inductance and capacity loosely coupled to what appears to be an open circuit. This is on the fourth page from the last.

The Court: Draw a line with a blue pencil there alongside of the passage, from beginning to end of the passage. This will identify it.

(So indicated.)

16. Cross-question. Now, will you point out where there is any ground connection or antenna shown in those two diagrams that you have just marked with a blue pencil?

Answer. I did not indicate it, presumably for the reason that it is pretty hard to take notes from a fast lecturer. He covered a large subject in two lectures.

17. Cross-question. On the last page of these notes which you have produced I see the words "Pupin. Condenser coupled." Were those words put on at the time you made these notes in 1901?

Answer. I do not recall that they were put on them.

18. Cross-question. Is that your handwriting?

Answer. Yes, sir.

19. Cross-question. Were they put on at the same time that the other handwriting on that page was put on?

Answer. I do not recall. It may be that they were not, because I read the article after he made reference to it. He finished the lecture at that time, and subsequently I read the article.

20. Cross-question. These words look to me as if they were put on with a different pencil, either softer or harder than the other pencil notes on the same page; isn't that true?

Answer. It may be; it looks that way. I had no difficulty in identifying the article to which he referred us.

Mr. Betts: Your honor, I want to call attention to this, that in the copy that has been offered in evidence in the book, I find in pencil under the words I have called the witness's attention to, the following: "This note added 3/16/1915."

Mr. Knight: I just noted that myself, and I would like to ask the witness what he knows about that.

The Court: Who put that there? This is in pencil.

21. Cross-question. I show you the photolithographic copy which has been offered in evidence, and call your attention to the fact that the words "This note added 3/16/1915" have been written on this photolithographic copy under the words "Pupin. Condenser coupled." Do you know anything about these added words in pencil on this photolithographic copy?

Answer. I believe that that is my handwriting and it must have been that I wrote that there on that page.

22. Cross-question. So that, as I understand it, the words "Pupin. Condenser coupled" on the last page of your original notes were put onto these original notes on the 16th day of March, 1915?

Answer. Apparently.

[fol. 685] 23. Cross-question. On the third page of your original notes, defendants' Exhibit F-3a, I find the words "Use coils without iron. Use condenser without dielectric of capacity." Is that right?

Answer. Yes; I think so.

24. Cross-question. Why did Mr. Stone want to use condensers without dielectric of capacity?

Answer. I do not recall.

25. Cross-question. What is such a condenser?

Answer. Well, every condenser must have some dielectric capacity, but I presume he meant to say with a minimum amount of dielectric capacity. That is probably what was meant.

26. Cross-question. Will you now please describe the Duguet apparatus which you say you installed in the Norfolk Navy Yard?

Answer. That has been about 12 years ago, and for the last 7 or 8 years I have not been concerned with wireless telegraphy, so it may be that I can not recall all the special arrangements of that particular set. I remember that some of the principal points are the reciprocating mechanism for producing the make and break primary circuit, by means of a motor, and that the coherer was a wood tube with adjustable terminals for varying its adjustment, and that the detector was shielded in an iron box from stray signals.

27. Cross-question. Is that all you can now remember about that installation?

Answer. That is all that occurs to me.

28. Cross-question. On page 5 of defendants' Exhibit F-3a I see the words "For oscillatory vibrations for a very small length of time"; what do you mean by "small length of time"?

Answer. I do not recall what that means.

Redirect examination.

By Mr. Knight:

29. Redirect question. In which lecture was it that this remark occurred, which you have noted as "Condensers without dielectric of capacity," and what was being described at that time?

Answer. That was in the first lecture, and it was in connection with the harmonic wave, simple wave, without complex wave form; a pure wave, in other words.

30. Redirect question. Had Mr. Stone taken up his own idea in wireless, any development he had of his own at that time, or was that general discussion?

Answer. I believe this was general.

31. Redirect question. Now, referring to the mark on page 5, I think it was called, "Oscillatory vibrations for a very small length of time"; what was the subject under discussion then, and at which lecture was this?

Answer. This was at the beginning of the second lecture, and appears to relate to the efficient transmission or interchange of energy between two circuits.

32. Redirect question. Your attention was called to a pencil note which you added to this photolithographic copy which forms a part of Exhibit F-3a. Had you forgotten that you had made this note?

Answer. Yes; as to the exact time when I made it.

33. Redirect question. Does this mean that the particular words, "Pupin. Condenser coupled" were written on that date, the 16th day of March, 1915?

[fol. 686] Answer. I think so.

34. Redirect question. Does that apply to any other part of this article?

Answer. I am afraid I do not understand your question.

35. Redirect question. Was any other part of this article as here copied written then for the first time?

Answer. The article in the book?

36. Redirect question. By "article" I mean these notes?

Answer. That is the only thing; yes, sir.

37. Redirect question. Do you now remember how you came to make this addition to the notes?

Answer. After having reread the article referred to in the lecture, I probably jotted that down to indicate the particular bearing on the subject in question.

[fol. 687] *Deposition of Edward H. Loftin, for defendants, taken at New York City, commencing on the 21st day of January, A. D. 1924*

EDWARD H. LOFTIN, having been produced as a witness on behalf of the defendant, was by me sworn, before any question was put to him, to tell the truth, the whole truth, and nothing but the truth, relative to the said question, and thereupon deposed and said that his name is Edward H. Loftin; that his occupation is lieutenant commander in the United States Navy; that he is 38 years of age; that his residence is Washington, D. C.; that he has no interest, direct or indirect, in the claim in controversy; and that he is not related to plaintiff; and thereupon the said Edward H. Loftin was examined by counsel for the defendant and in answer to interrogatories testified as follows:

Direct examination.

By Mr. Edwards:

1. Question. What has been your training and experience in scientific and electrical matter, and particularly your experience in the field of wireless telegraphy and telephony?

Answer. I graduated from the United States Naval Academy in 1908, after the usual four-year academic course given in the creation of officer material for the United States Navy, which course includes almost all of the applied sciences, including electricity and radio. In 1910, while an officer aboard the U. S. S. *Maricetta*, then on duty in Central American waters, in connection with guarding American interests during insurrections and radio communication was the only form of communication with the United States, [fol. 688] I was detailed to duty by the commanding officer to supervise the radio equipment in order to be assured communication, this being my first practical association with radio apparatus, and this duty lasting for a period of six months. In 1912 I was assigned to duty as commanding officer of the U. S. S. *Bailen*, which vessel was at that time [fol. 689] engaged in special radio experimental work involving many forms of investigation of radio communication, and which vessel was at that time equipped with the then latest transmitting and receiving apparatus and other special devices, and I remained on this duty trying out various experiments for one year. In 1913 I was ordered to a post-graduate course in engineering, consisting of one year at the post-graduate school at Annapolis, Md., followed by one year at Columbia University, New York City. In this course I specialized in electrical and radio engineering and as a result, was awarded the degree of master of arts at Columbia University, this being in 1915.

In 1916 I was detailed by the Navy Department to undertake the development of radio apparatus suitable for aircraft, no practical apparatus for this purpose being then developed by this Government. While performing this duty I was also assigned to additional duty as district communication superintendent of the eighth naval district, which includes all of the Gulf coast of the United States, having radio stations at Pensacola, New Orleans, and Point Isabel, Tex., which duty involved not only the direction of radio traffic in the district, but the maintenance of the radio

material. In connection with these duties I was further assigned special experimental work investigating the use to which the Navy could make of buried wires as antennae for radio systems, and supervised elaborate experiments at New Orleans in this connection.

In 1917 I was detailed to duty as the radio officer of the fifth division of battleships of the United States Atlantic Fleet and after three months of this duty was, during the war, ordered to Europe as radio officer for the United States Naval Aviation Forces then being established in France and Ireland, and had as additional duty the negotiations for and arrangements with the French Government for a higher-power radio station for communications with the United States, which station was constructed and is still in existence, being known as the Lafayette radio station. While in France, I had additional duties as member of the Inter-Allied Technical Radio Committee, involving numerous conferences with the technicians of the Allies involving radio subjects of all kinds. Later I was also assigned to duty as communication officer for the naval forces in France, which included the establishment of means of communication by wire, and before the end of the war I had supervised the building of 1,000 miles of telephone and telegraph lines.

In 1918, immediately after the signing of the armistice, I was ordered to the Bureau of Engineering, Navy Department, Washington, and was assigned duty as officer in charge of radio research and development, involving the supervision of all the new radio work undertaken by the naval forces.

In 1919, I was assigned additional duty as a member of a board which became known as the Inter-Departmental Radio Board, and had for its purpose the hearing of a large number of claims against the Government for the use of radio patents, and I was elected chairman of that board. During two years and a half this board considered hundreds of patents which were brought before it, in support of the claims against the Government, and a consideration of these claims involved a complete study of the radio art since its inception. Although the board completed its work and made definite recommendations for the settlement of [fol. 690] claims, the purpose of the board failed due to failure of Congress to make the necessary appropriations to cover the recommendations of the board for settlement,

with the result that most of the claims now stand in the form of suits against the United States, and since the completion of the board's work I have been retained on duty in Washington as a constant technical adviser to the officers of the Department of Justice charged with the defense of these suits. In 1921 I was one of the delegates of the United States to a meeting of the provisional technical committee of the International Communication Congress, which committee met in Paris, France.

2. Question. Will you state, in a general way, the early development of wireless telegraphy prior to December, 1896?

Answer. Wireless telegraphy generally refers to the transmission of intelligence over distance without the use of wires as the medium of conducting the necessary energy manifestations which are employed to operate the receivers. Probably the first disclosure of the transmission of electrical energy without the use of wires was contained in the theory of Clerk Maxwell, known as the Maxwellian theory, which was divulged about 70 years ago. Maxwell did not accompany his theory with any proposed apparatus for usefully employing it. The German scientist Hertz, between the years 1879 and 1890, carried out many practical demonstrations of the Maxwellian theory. Hertz demonstrated that by the use of very high frequency electrical oscillations disturbances could be produced in space which could be detected at a distance. He proved that these disturbances had many of the properties of light waves, including reflection, refraction, polarization, and the velocity of light waves. His means for detecting these energy-bearing waves was simple, consisting of a small loop of wire, having its two ends almost but not quite closed. When the loop was inserted in the field of waves generated, it intercepted some of their energy, causing electrical oscillations, which manifested itself in the form of sparks across the slight gap left in the loop.

In the Fortnightly Review of February, 1892, in an article entitled "Some possibilities of electricity," commencing on page 173, Prof. William Crooks very definitely suggests the use of the waves investigated by Hertz for wireless telegraphy, commenting that telegraphing without wires was even then possible within a restricted radius of a few hundred yards, and that with the discovery of a sufficiently sensitive receiver and powerful transmitter this

use would be brought within the grasp of daily life. He also pointed out that by tuning both sending and receiving instruments, electrically, to one and the same length of electric wave, the desired secrecy could be obtained in a message passed between any one pair of stations. He did not suggest any definite form of apparatus, except that it should produce Hertzian waves under the control of a sending operator's key to make ordinary dots and dashes of the Morse code.

The suggestion of Crooks was very quickly followed by one of Nikola Tesla, more definite in its proposal of practical apparatus. Tesla delivered before the Franklin Institute, Philadelphia, February, 1893, a lecture on "Light and other high frequency phenomenon," as reported in a book entitled "Inventions, Researches, and Writings of Nikola Tesla," by Martin, published in 1894. Investigations of Hertz discharged that in order to create energy-bearing waves it was necessary to produce high-frequency [fol. 691] currents or rapid electrical oscillations. The Tesla book of Martin, beginning at page 302, and taken particularly in connection with Figure 165, shows how to produce such currents or oscillations using ordinary dynamo machines. Referring particularly to the system illustrated as the second from the left in Figure 165, the circuit containing the inductive winding P, the condenser C, and including the two spark gaps *d d*, which circuit is supplied with energy from the dynamo G through the step-up transformer T, is particularly suitable for producing high-frequency currents or electrical oscillations of large energy, and also adjustable in frequency or period of vibration. The Tesla book describes various applications to which the high-frequency currents produced by the system illustrated in Figure 165 may be put and on page 346 definitely proposes the production of electric waves by such currents for the transmission of telegraph messages without wires. On page 348, in connection with Figure 185, he suggests an electric-wave-producing system for association with a source of high-frequency currents, a system comprising an elevated conducting surface P connected to one of the terminals of the source, the other terminal of the source being connected to the earth or water mains presumably buried in the earth. It is reasonable to associate the system in Figure 185 with any one of the numerous systems illustrated in Figure 165 for producing high-frequency currents.

I have made such an association in a sketch marked "Loftin Sketch A-Tesla Transmitter," inserted opposite. Referring to Figure 165, the second system from the left, G is a generator clearly illustrated as generating alternating currents, and reasonable to assume that these currents had at that period a frequency of 60 cycles per second. These currents are delivered to a transformer T through a switch S, having two blades. A transformer is clearly indicated as one suitable for raising the voltage of the generator to a high voltage, the number of turns of the secondary winding S being illustrated as greater than the number of turns of the unmarked primary winding. The currents raised to high voltage by the transformer T are delivered to the condenser C, which stores the energy in the current until a potential sufficiently high to break down the resistance of the two spark gaps $d d$ is had. When the spark gap resistance is broken down current flows across the gap ionizing the air path, reducing the resistance from a very — value to a very low value. There then exists a circuit containing the condenser C and the inductance of the primary winding P having sufficiently low resistance to be an oscillatory circuit and the current will continue to oscillate in this circuit until the energy is sufficiently expended to reduce the ionization in the gap $d d$ to a point where the resistance becomes too high to permit further flow of current. This oscillating current flowing through the winding P will set up a magnetic field linking with the winding S', thus creating an electromotive force in the system containing the elevated conductor T and the wire grounded to the earth at E, and in response [fol. 692] to this electromotive force, high frequency currents will flow in the system. These high frequency currents will create disturbances in the surrounding ether which can be detected at great distances with suitable apparatus. The operation described takes place for each half cycle or half alternation of the generator G.

The oscillations can be made as powerful as desired by a proper selection of the generator G and the accompanying apparatus, and the frequency of the oscillations controlled by the selection of proper values for the condenser C, and inductive winding P, this controlled frequency or tuning having been understood by Hertz, is also referred to by Crooks, and is thoroughly dealt with by Tesla in the Tesla book.

In the article by Sir William Crooks, at the bottom of page 174, he states:

"What, therefore, remains to be discovered is, firstly, simpler and more certain means of generating electrical rays of any desired wave length."

In the Tesla transmitter, which I have illustrated, there was disclosed a means so simple and so certain of generating the rays referred to by Crooks that it was universally adopted and still remains the basic arrangement in radio transmitters.

While Tesla did not specifically illustrate a switch generally known as an operator's key, for making dots and dashes in the Morse code, I consider that the insertion of such a key in a system was decidedly obvious to those skilled in the art at that time. It was certainly obvious that by closing one blade of the switch S and then operating the other blade of the switch to open and close the circuit A for long and short intervals, to make dots and dashes of the code, was well within the possibility of his device, and it would have required no more than mere mechanical skill to put the ordinary operator's knob on top of the blade and a spring device under the blade to arrive at a quick acting operator's key, or to insert in place of the blade well known commercial designs of such keys available at the time of Tesla.

The lectures of Tesla in 1893 and 1894 and the Tesla book of 1894 attracted widespread attention, some of which is indicated by the following expressions from persons skilled in the art:

Swinton in the *Electrician*, of London, October 22, 1897, page 869, calls attention to Tesla's book of 1894, pages 346 and 349, and accords to Tesla credit for a share in the work of bringing about practicable and commercial wireless telegraphy. Prof. S. E. Thompson in his paper on "Telegraphy across space," printed in the *Journal of the Society of Arts*, London, 1898, and reprinted in the *Smithsonian Institute Report for 1898*, shows on page 243 how Lodge had demonstrated the possibility of transmitting telegraph signals wirelessly by Hertzian waves at Oxford, in 1894, to a distance of 100 or 150 yards. He then goes on to state of Tesla's work as follows:

"Even before this, Mr. Nickola Tesla, in a lecture delivered at St. Louis in 1893, had made a further suggestion of great importance. He proposed to transmit electric energy by oscillations to any distance, without communicating wires, by erecting at each end of the stretch a vertical conductor joined at its lower part to the earth, and at its upper to a conducting body of large surface. This [fol. 693] constitutes a vertical base line from which to disseminate the oscillating disturbances."

Taking up now the second requirement set up by Prof. William Crooks to bring wireless telegraphy within the grasp of daily life, that of a sensitive detector or receiver of the energy set off into space by the transmitter or generator or electrical energy disturbances in space, at the close of Hertz's work, the only detector for making electric waves apparent to the senses was the loop of wire including a little spark gap at the two ends brought to a near closure. In 1891, Branly discovered that very thin layers of metal deposited upon glass sheets had their electrical conducting powers affected when an electric wave disturbance reached them. He also discovered that metallic powders acted in the same way. Lodge repeated the experimental work of Hertz, and the *Electrician*, June 15, 1894, page 189, Figure 18, described an account of Lodge's lecture before the royal institution covering his repetition of Hertz's work, and brings out that Lodge substituted for the minute spark gap of Hertz the detector of Branly used in the form of a tube filled with coarse iron filings, which device Lodge termed a "coherer." Lodge showed that when such a coherer was placed in a conducting path, subjected to electric waves, the filings conducted electricity very poorly until the passing wave struck the apparatus, when the electric impulse passing along the tube through the filings caused them in some manner to cohere; thereupon the filings conducted electricity much better. In order to restore the coherer to its original nonconducting condition after the passage of the invisible waves, it was necessary to shake the *the* tube so as to break up the cohesion between the filings.

Professor Popoff, of Russia, followed up the work of Branly and Lodge and improved the coherer. His work is covered in a paper to the coherer. His work is covered in a paper to the Russian Physical Chemical Society's

Journal at the Imperial St. Petersburg University in 1896, entitled (according to the translation) "Apparatus for detection and registration of electrical vibrations." The paper is dated Cronstadt, December, 1895. It refers to the work of Branly and Lodge. It describes an improved form of coherer which he, Popoff, had developed, and to which he accredits great sensitiveness.

Answer to question 2 continued. Popoff illustrated his coherer in Figure 1 of the paper, and in Figure 2 associated with it the necessary apparatus for making the coherer effective. Commencing in the last paragraph of page 15 of the translation of the Popoff paper there is a description of the manner in which Figure 2 was connected to an elevated conductor and to ground for the purpose of detecting atmospheric disturbances, and I have reproduced Figure 2 and applied the connections described for the purpose of atmospheric disturbance detection in a sketch marked "Loftin Sketch B—Popoff Receiver," and for the purpose of description I have added reference letters not found in Figure 2 of the paper. L represents the coherer which is connected to an elevated conductor C at the point A, the conductor being described by Popoff as approximately 28 feet high. The coherer is also connected to ground from [fol. 694] the opposite side B, the ground connection being described as through a water-net system illustrated at E. Around the coherer there is connected to a battery Q whose current when it flows passes through the coils R1, R2, and the magnetic winding M1 as well as through a coherer. When current flows, the contact C1 is closed by the action of the electromagnet M1, and this allows some of the battery current to flow through the electromagnet M2 through the contact C2. The current through the electromagnet M2 will cause the tapper T to be drawn upward striking the bell Y and opening the contacts C2. The contacts C2 being thus opened, there will be no further pull on the tapper T and it will drop back striking the coherer L, giving it a jar. Normally, the metallic filings in the coherer L will not permit sufficient current to flow through the electromagnet M1 to cause it to operate. When an electrical disturbance strikes the elevated conductor C, there will result a very large reduction in the resistance in the metallic filings path, and sufficient current will flow from the battery Q to actuate the electromagnet M1, and, as before described, result in a ringing of the bell Y, and

tapping of the coherer L restoring the filing to a non-conductive state. This operation will continue as long as the electrical disturbance acts upon the elevated conductor C.

The paper fully describes how atmospheric disturbances were observed from day to day at times when meteorological observations reported the existence of electrical storms. In addition the paper tells how electrical disturbances were set up by electrical apparatus in the vicinity in actuating meteorological instruments.

In concluding his paper, Popoff showed that he appreciated the application of his coherer to wireless telegraphy. He states:

"In conclusion, I can express the hope that my apparatus, with further improvements of the same, may be adapted to the transmission of signals at a distance by the aid of quick electric vibrations, as soon as the source of such vibration possessing sufficient energy will be found."

That work was fully appreciated is reflected in such articles as that of the Scientific American supplements for 1898, volume 46, page 18874, in which is found the following paragraph:

"In 1889 W. E. Branly invented the radio conductor, which he has himself described in these pages. This apparatus is a very sensitive revealer of waves emitted, even at a great distance. It is through the use of such apparatus and of the principles of which we have just spoken that the Russian Professor Popoff in 1895 made his experiments in wireless telegraphy. To this effect he devised an apparatus for registering the electric wave produced by atmospheric disturbances and for transmitting to a distance signals registered in the North Pole. These experiments were resumed by Mr. Marconi in 1896."

Also the well-known French scientist Ducretet in a lecture before the International Society of Electricians of Paris, June 1, 1898, and reported in *L'Electricien* of October 8, 1898, page 235, et seq., takes full cognizance of Popoff's work, and I find a paragraph on page 237 which is particularly significant and which I translate as follows:

"Since 1895 M. Popoff has shown in his publications and in his contributions to scientific societies in Russia that his apparatus could be practically employed in the navy for the reception of long-distance signals transmitted through space."

[fol. 695] In the paper of Sir William Crookes, which I have heretofore mentioned, he stated at the top of page 175, as second requirement for bringing wireless telegraphy within the grasp of daily life as "more delicate receivers which will respond to wave lengths between certain defined limits and be silent to all others."

While the Popoff paper did not touch upon the responsiveness to wave lengths between certain defined limits, it fulfilled the requirements as to delicacy or sensitiveness, and, furthermore, provided a receiver which was automatically self-restoring. I have referred to the work of Hertz without any definite reference to its publication, because his work is so well known to those practicing the art of radiotelegraphy, but for the purpose of definitely including in the record references to publications bearing upon the subject a rather full account is found in the series of articles by G. W. de Tunzelmann in the *Electrician*, London, between September 14 and November 16, 1888. Also the published accounts by Prof. Oliver Lodge in the *Electrician*, London, in a series of articles entitled "The Work of Hertz" between June 8 and July 20, 1894.

I have referred to a translation of an article by Professor Popoff from the journal of the Russian Physical Chemical Society at the Imperial St. Petersburg University. Translations in abstract are given from the original Russian article by Popoff in the *Electrician*, London, December 10, 1897, page 235, volume 40, purporting to be signed by professor Popoff in Cronstadt, Russia, November 26, 1897.

Mr. Edwards, Counsel for defendant offers in evidence the following exhibits in connection with the Stone defense:

United States patent to Stone No. 714756, dated December 2, 1902, marked "Defendant's Exhibit P3."

United States patent to Stone No. 714831, dated December 2, 1902, marked "Defendant's Exhibit Q3."

Certified copy of file wrapper and contents of United States patent to Stone No. 714756, dated December 2, 1902, marked "Defendant's Exhibit R3."

Certified copy of file wrapper and contents of United States patent to Stone No. 714831, dated December 2, 1902, marked "Defendant's Exhibit S3."

United States patent to Stone No. 577214, dated February 16, 1897, marked "Defendant's Exhibit T3."

United States patent to Stone No. 638152, November 28, 1899, marked "Defendant's Exhibit U3."

United States patent to Stone No. 726476, dated April 28, 1903, marked "Defendant's Exhibit V3."

United States patent to Stone No. 767990, dated August 16, 1904, marked "Defendant's Exhibit W3."

United States patent to Stone No. 726368, dated April 28, 1903, marked "Defendant's Exhibit X3."

Certified copy of file wrapper of United States patent to Stone No. 726368, granted April 28, 1903, marked "Defendant's Exhibit Y3."

Certified copy of file wrapper of United States patent to Stone No. 767975, dated August 16, 1904, marked "Defendant's Exhibit Z3."

Defendant's counsel also offers in evidence the following exhibits referred to in the deposition of the present witness, Commander Loftin:

[fols. 696-697] The Fortnightly Review, published in February, 1892, pages 173 to 181, inclusive, containing article by Crookes entitled "Some Possibilities of Electricity," marked "Defendant's Exhibit A4."

Pages 165, 169, 174, 188 to 193, inclusive, 202, 203, 207, 208, 210 to 213, inclusive, 225, 226, 231, 234, 303 to 313, inclusive, 317, 332 33, 337, 40 to 49, inclusive, 381 to 384, 488, and 489 of a book entitled "Inventions, Researches, and Writings of Nikola Tesla," by Martin published in 1894, marked "Defendant's Exhibit B4."

Page 869 of the Electrician, published at London, England, October 22, 1897, marked "Defendant's Exhibit C4."

Pages 235 to 247, inclusive, of the Journal of the Society of Arts, published at London, England, 1898, marked "Defendant's Exhibit D4."

Pages 153, 154, and 155 of the London Electrician, published June 8, 1894; pages 186 to 190, inclusive, of the same publication, published June 15, 1894, pages 204 and 205, of the same publication, published June 22, 1894; pages 271 to 274, inclusive, of the same publication, published July 6, 1894; page 299 of the same publication, published

July 13, 1894; and pages 332 to 335, inclusive, of the same publication, published July 20, 1894. All of these articles are offered as one exhibit and marked "Defendant's Exhibit E4."

Translation of an article published in the Journal of the Russian Physico-Chemical Society at the Imperial St. Petersburg University, Russia, in 1896, by A. S. Popoff, marked "Defendant's Exhibit F4."

Page 18874 of the Scientific American Supplement, published at New York, 1898, volume 46, marked "Defendant's Exhibit G4."

Pages 235 to 237, inclusive, of L'Electricien, published at Paris, France, October 8, 1898, marked "Defendant's Exhibit H4."

Page 235 of the Electrician, published at London, England, December 10, 1897, marked "Defendant's Exhibit 14."

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[fol. 698] 5. Question. In your opinion, if an electrical engineer were given the work of Hertz, Tesla, Lodge, and Popoff and the forecast of Crookes, could he produce a system of transmitting and receiving intelligible signals without the use of wires without being compelled to devise anything especially new, and if so, what, in your opinion, would be the essentials of the system which he would naturally produce in view of such prior disclosures?

Answer. I have already pointed out in my answer to question 2 that the prediction of Crookes was predicated on the laboratory experiments of Hertz, Crookes suggesting that all the Hertz experiments needed to bring wireless telegraphy within the grasp of daily life was a more simple and certain means of generating high-frequency oscillations and a more sensitive detector of these oscillations. When this apparatus became available messages could be sent employing dots and dashes of the Morse code as was then the practice in wire telegraphy. I have also shown that immediately following the prediction and suggestion of Crookes, Tesla came forward with numerous forms of apparatus for producing high-frequency oscillations, and of these forms I have selected one and illustrated it in my sketch marked "Loftin Sketch A—Tesla Transmitter," my selection of this particular form having been [fol. 699] due to the fact that it is basically the organization

of apparatus which had been universally adopted as a radio or wireless transmitter, there being tens of thousands of transmitters of this type in use to-day. I have pointed out that it required no special knowledge to apply an ordinary telegraphy switch to the Tesla transmitter in place of the knife-blade switch shown in the Tesla sketch, thus making his system fulfill all the requirements set up by Crookes.

I have also illustrated in the sketch marked "Loftin Sketch B—Popoff Receiver" a sensitive receiver developed by Professor Popoff, whose work was specifically recognized by Marconi in the last paragraph but one of his re-issue patent, the sketch also including the way in which Popoff connected his receiver to a grounded elevated conductor and successfully received electrical disturbances through space originating in distant electrical storms, together with electrical disturbances artificially created in electrical circuits operating meteorological instruments which happened to be in the vicinity of the location Popoff chose for setting up his receiver of atmospheric electrical disturbances.

So complete and full were the disclosures of Tesla and Popoff that all that was required of one skilled in the art to produce a successful system of wireless communication was to set up the devices of Tesla and Popoff, operating the Tesla transmitter to make dots and dashes of the Morse code as suggested by Crookes. It would not have been necessary to even refer to the very complete considerations of the subject by Lodge.

6. Question. How does the character of wave, oscillations, or radiations of the patent in suit compare with those used by Lodge in 1894, by Popoff in 1895, and by Tesla during the early nineties.

Answer. The Marconi patent in suit, the articles by Lodge in 1894, and by Popoff in 1895 all refer to the character of the transmission of energy through space with which they were dealing as Hertzian waves. Tesla did not so characterize his mode of space energy transmission, but from the apparatus and structures used it was essentially the same as the others.

[fol. 700] (Defendant's counsel offers in evidence the following publications, patents, and sketches referred to by the witness, Loftin:)

Defendant's Exhibits—

J-4. Pages 183 and 184 of *Electric Waves* by Hertz, published at London in 1893.

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[fol. 701] R-4. Loftin sketch A.

S-4. Loftin sketch B.

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[fol. 702] "*Resonance phenomena*.—In order to determine whether, as some minor phenomena had led the author to suppose, the oscillations were of the nature of a regular vibration, he availed himself of the principle of resonance. According to this principle, an oscillatory current of definite period would, other conditions being the same, exert a much greater inductive effect upon one of equal period than upon one differing even slightly from it.

"If, then, two circuits are taken having as nearly as possible equal vibration periods, the effect of one upon the other will be diminished by altering either the capacity or the coefficient of self-induction of one of them; as a change in either of them would alter the period of vibration of the circuit."

It is thus apparent that Hertz appreciated that the best transfer of energy would take place when the transmitting and receiving circuits were tuned one to the other, and arrived at this conclusion through the application of the ordinary principles of resonance phenomena. Also that he fully appreciated the manner in which such tuning could be accomplished, namely, by adjusting either the capacity or the self-induction.

That Hertz appreciated the mathematical relation existing between the frequency or period of electrical circuits and the values of the capacity and inductance, is shown in the De Tunzelmann article appearing in the *Electrician*, September 14, 1888, for at page 588 it states:

"These periods are determined by the products of the coefficients of self-induction of these conductors even to the capacity of their terminals, and are practically independent of their resistances."

This statement of the mathematical relation is the practical foundation for the mathematical formula in common use to-day expressing the relation between the frequency and the inductance and capacity of electrical circuits.

In confirmation of the above-quoted conclusions as to the relation of these elements, the article states at the bottom of page 588 and the top of page 589, as follows:

"In confirmation of this it is found that if, when the point of contact is at *c* and the sparks have been made to reappear by connecting a conductor with one of the knobs, this conductor is replaced by one of greater capacity, sparking is greatly increased.

"The conclusions were further confirmed by the results when coils of copper wire were inserted into one or other and then into both of the branches of the micrometer circuit."

This is evidence that Hertz not only appreciated the relation of capacity to inductance but devised a practical means of obtaining self-induction in a circuit, namely, a coil of wire, which is precisely the same means covered by the claim in suit of the Lodge patent.

That the practical application of the Hertz disclosures to wireless telegraphy was apparent is shown by defendant's Exhibit A-4, Crookes' article of February, 1892. The article states on page 175:

[fol. 703] "If, however, the sender and receiver were moving about, so that the lens device could not be adopted, the correspondents must attune their instruments to a definite wave length, say, for example, 50 yards. I assume here that the progress of discovery would give instruments capable of adjustment by turning a screw or altering the length of a wire, so as to become receptive of wave lengths of any preconcerted length. Thus, when adjusted to 50 yards, the transmitter might emit, and the receiver respond to, rays varying between 45 and 55 yards, and be silent to all others."

This adjustment of instruments by the mere turning of a screw predicted by Crookes is exactly what happens in practical apparatus in radio communication. As soon as radio apparatus came into commercial use, the designers immediately arranged to vary the capacity and the inductance by the mere turning of convenient knobs. Also the limits of selectivity suggested by Crookes compare very favorably with what is obtained in actual practice. Crookes expressed the wave length in yards, while in the radio art as practiced the wave lengths are expressed in meters. In

a modern receiver tuned, for instance, to 300 meters one does not expect to hear only transmitting stations also tuned to 300 meters but finds that station tuned to 275 meters and 325 meters are also heard, while stations tuned to 200 meters or 400 meters become very faint or not heard at all, depending upon a number of considerations.

That Tesla understood in 1893 and 1894 how to construct electrical oscillation producers or transmitters having tuned circuits is apparent from reference to defendant's Exhibit B-4, Tesla book. He takes up at considerable length the methods of tuning the various circuits of the oscillation producers illustrated in Figure 165 (p. 303). The book states at page 305 that the frequency may be adjusted "by the determination of the capacity, self-induction, and resistance of the circuit." At page 315 of the book it is explained that tuning may be accomplished by means of an adjustable condenser C, Figure IIa, and also through an adjustable self-induction coil in series with the circuit. On page 317, in considering the arrangement of Figure IIIb, the secondary circuit is provided with an adjustable condenser for the purpose of tuning it to the primary.

I have shown in "Loftin Sketch A—Tesla Transmitter," inserted opposite page 427 of the typewritten record, that when Tesla connected an elevated conductor as provided for in Figure 185, page 348, to one of the oscillation producers illustrated in Figure 165, there is a coil of wire included in the elevated conductor between the elevated capacity area P and the earth E, which is the arrangement provided for in claims 1, 2, and 5 in suit of the Lodge patent. In fact, it is impossible to use any of the oscillation producers illustrated by Tesla without introducing an inductance coil in the elevated conductor circuit provided for in Figure 185.

In a book by Prof. Oliver Lodge entitled "Lightning Conductors and Lightning Guards," printed in London in 1892, there is discussed at great length the oscillatory paths, consisting of any one of short wires, long wires, and spiral wires. Lodge shows in Figure 47, page 352, a jar discharging either through a very short wire or through a spiral wire of half a dozen turns, and on page 354, states as follows:

"14. The noteworthy circumstance in all these experiments is the remarkable action of a long, thick, and good

[fol. 704] conductor in causing the jar to overflow, especially if it be insulated, the most powerful conductor for this purpose being one with suitable self-induction and capacity but very little resistance. Evidently such a conductor assists the formation of an electric surging, whose accumulated momentum charges the jar momentarily up to bursting point. Resistance damps the vibrations down, and short wires have insufficient electric inertia and capacity to get them up."

This shows that Lodge appreciated that large capacity and self-inductance was necessary in order for oscillation to build up and be prolonged or sustained, and that the proper inductance is obtainable through the use of a spiral or coil of wire.

Lodge, after referring to the work of Hertz, in a book entitled "Modern Views of Electricity," published in London, 1889, states on page 373:

"One immediate consequence and easy proof of the oscillatory character of a Leyden jar discharge is the occurrence of phenomena of sympathetic resonance.

"Everyone knows that one tuning fork can excite another at a reasonable distance if both are tuned to the same note. Everyone knows, also, that a fork can throw a stretched string attached to it into sympathetic vibration if the two are tuned to unison or to some simple harmonical. Both these effects have their electrical analogue. I have not time to go fully into the matter to-night, but I may just mention the two cases which I have myself specially noticed.

"A Leyden jar discharge can so excite a similarly timed neighboring Leyden jar circuit as to cause the latter to burst its dielectric if thin and weak enough. The well-timed impulses accumulate in the neighboring circuit until they break through a quite perceptible thickness of air.

"Put the circuits out of unison by varying the capacity or by including a longer wire in one of them, then, although the added wire be a coil of several turns, well adapted to assist neutral induction as ordinarily understood, the effect will no longer occur. It can be obtained again by diminishing the static capacity."

This shows that Lodge considered the resonance phenomena between electrical circuits to be the same as that between tuning forks, stretched strings, or other well-known

forms of vibrators, and that the tuning could be controlled by varying capacity or inductance, and one way of controlling inductance was the use of a coil of wire.

A paper entitled "d'Arsonval's Modification of Current of Great Frequency," published in a book entitled "Transactions of the American Therapeutic Association," New York, 1894, there is stated in reference to apparatus for producing rapid operations by the discharge of a condenser as follows:

"This is the method employed by Doctor Hertz to produce extremely rapid electrical undulations. * * * The duration and number of oscillations may be measured by examining the discharge by means of a turning mirror."

The article then states the formula for determining the frequency of oscillations of an electrical circuit depending upon the inductance and capacity, and further states:

"We may consequently give to T values more definite by modifying L and C. Doctor Hertz has obtained one-billionth [fol. 705-706] of a second; and my friend, Mr. Potier, has been able to lower the oscillating period so as to give to the Leyden jar a musical sound perceptible to the ear. In my first experiments I employed a Hertz vibrator. Later, I employed the more powerful arrangement suggested by M. Elihu Thomson and by Tesla. In my recent researches I found great advantage in the exclusive employment of the following apparatus for which the experiments of M. Lodge has given me many suggestions. * * *"

The article then describes apparatus including an oscillatory circuit having two capacity areas with an inductance coil inserted between them comprising a winding of 15 or 20 turns of coarse copper wire.

This article shows that the author had no difficulty in linking up the apparatus of Hertz, Tesla, Lodge, and his own as the same manner of apparatus, and fully realized the matter of varying the period of such electrical circuits, and using a coil of wire as the inductance element of the circuit.

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[fol. 707] 21. Question. Please explain the nature and operation of the device described in the Marconi patent No. 763772 here in suit having particular reference to the

subject-matter set forth in claims 1, 2, 3, 6, 8, and 10, to 20, inclusive.

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Answer. The specification of Marconi patent 763772 in suit, briefly states in opening, lines 10 to 19, inclusive, page 1, the nature and purpose of the apparatus as follows:

"My invention relates to apparatus for communicating electrical signals without wires and by means of Hertz oscillations or electric waves; and the object of the invention is to increase the efficiency of the system and to provide new and simple means whereby oscillations or electric waves from a transmitting-station may be localized when desired at any one selected receiving station or stations out of a group of several receiving stations."

The general procedure of communicating electric signals without wires and by means of Hertz oscillations or electric waves has been freely discussed in connection with the Marconi reissue patent and the Lodge patent in suit, and is thought to need no further comments in connection with the consideration of this patent. The quotation gives two objects for the invention, namely, "to increase the efficiency of the system" and localizing the electric waves at a selected receiving station.

The first object is rather indefinite, as there is no indication of the kind of efficiency Marconi proposes to increase. For instance, it could refer to efficiency from the point of view of economy of electrical energy, or it may have in mind efficiency from the point of view of signalling to great distances without regard to the saving or waste of energy in accomplishing the long distance results. The second object, that of localizing signals at a particular receiving station is most definite, and subject to only one interpretation. Marconi desired to carry on communication between a given transmitting and receiving station without having the signals made unintelligible by interference from signals of other transmitting stations designed or adjusted to communicate on a different frequency.

The specification next refers to Marconi's prior patent, reissue No. 11913, here in suit, and describes the arrangement therein for communicating electrical signals. Having described the earlier apparatus, the specification then proceeds to state in general terms the outstanding features of

the new apparatus. The statement as to the transmitter, lines 33 to 47, page 1, is as follows:

"According to the present invention the system includes at the transmitting station the combination, with an oscillation transformer of a kind suitable for the transformation of very rapidly alternating currents of a persistent oscillator, and a good radiator, one coil of said transformer being connected between the aerial wire or plate and the connection thereof to earth, while the other coil of the transformer is connected in circuit with a condenser, a producer of Hertzian oscillations or electric waves shown in the form of a spark producer, and an induction coil (constituting the persistent oscillator) controlled by a signaling instrument."

Referring to Figure 1 of the drawing, this quotation states in effect that the oscillation transformer $d d'$ interlinks the elevated conductor A to a lateral circuit containing a condenser c and a spark gap or spark producer (unmarked), and that the elevated conductor is a good radiator, while the lateral circuit linked to it through the oscillation transformer must be a "persistent oscillator." The quotation refers to the spark producer as "a producer of Hertzian oscillations or electric waves." This statement, of course, is not exactly correct, a spark gap not being capable of itself to produce oscillations. It must be associated with a circuit having proper inductance, capacity, and resistance values, the capacity and inductance determining the frequency of the oscillations and the resistance determining whether or not oscillations are produced at all. If the resistance is too high no oscillations can be produced. The function of the spark gap is to provide a high resistance in the circuit intended to oscillate while the condenser, such as c in Figure 1, is being charged with electrical energy, and by adjustment of the length of the gap it can be caused to break down when a certain pressure or potential has been obtained in the condenser c , and thereafter remain a very low resistance path, while oscillations of electrical current in the oscillating circuit take place. The gap is therefore a trigger device and not of itself a generator or producer of electrical oscillations or alternating current.

The specification states further in generalizing the system, lines 56 to 66 inclusive, page 1, as follows:

"The system also requires as essential elements thereof the inclusion in the lines (at both stations) from the aerial

conductor to the earth of variable inductances and the use at both stations of means for varying or adjusting the inductance of the two circuits at each station to accord with each other. By this arrangement of apparatus I am able to secure a perfect 'tuning' of the apparatus at a transmitting station and at one or more of a number of receiving stations."

This quotation shows that Marconi, having associated a good radiator with a persistent oscillator, proposed as a second step toward obtaining his object the adjustment of the [fol. 709] several circuits included in his system so as to obtain "a perfect 'tuning'." That is, having associated a good radiator with a persistent oscillator, perfect tuning would then be possible.

The quotation taken by itself would indicate that Marconi proposed to accomplish his adjustment by the manipulation of inductance values only, but this is not in keeping with later statements in his specifications and with his drawings and descriptions of the elements illustrated in the drawings. For instance, the description of the condenser *c* at the transmitting station, Figure 1, and the description of the condensers *b* and *b'*, at the receiving station, Figure 2, make these devices variable. Marconi, of course, appreciated that circuits could be adjusted in time periods or frequency by varying either inductance or capacity, or both. For instance, at lines 123 to 126, inclusive, page 2, he states "are each and all to be so independently adjusted as to make the product of the self-induction multiplied by the capacity the same in each case."

Here he does not require the adjustment of inductance alone, as the product of inductance and capacity may be varied through varying capacity value.

Also referring to the table of tunes on page 4 of his specification, it will be noted that at the transmitting station he varied the value of the capacity of the condenser *c* more often than he varied the inductance.

The specification next sets forth in detail, lines 76 to 97, inclusive, the elements comprising the transmitting station illustrated in Figure 1. Following this statement of the elements it is stated that the induction coil *C*, may be replaced by other proper means, for instance, a generator of alternating electric current. The generator form of supply

of energy to a radio transmitting system is a common form encountered in practice.

The specification then specifically states, lines 6 to 24, inclusive, page 2, what this organization of apparatus at the transmitting station must do, as follows:

"The illustrated arrangement of parts at a transmitting station enables much more energy to be imparted to the radiator *f*, the approximately closed circuit of the primary being a good conserver and the open circuit of the secondary being a good radiator of wave energy. My experiments have demonstrated that the best results are obtained at the transmitting-station when I use a persistent oscillator—an electrical circuit of such a character that if electromotive force is suddenly applied to it and the current then cut off electrical oscillations are set up in the circuit which persist or are maintained for a long time—in the primary circuit and use a good radiator—i. e., an electrical circuit which very quickly imparts the energy of electrical oscillations to the surrounding ether in the form of waves—in the secondary circuit."

That is, in effect the lateral circuit must be capable of taking a large quantity of electrical energy from a source of supply, must be able to convert this energy into high frequency electrical currents or oscillations, must conserve the energy so as to spread the oscillations out over a long period of time, and must deliver energy to a good or rapid radiator in such a way that it will not be radiated too quickly by a good radiator, but drawn out over a long period of time. The lateral circuit must act as a reservoir for the [fol. 710] rapid radiator, always having a little more energy in store to replace that rapidly radiated. This quotation makes clear that providing the storage system of energy for a rapid radiator, such as the elevated conductor, much more energy can be radiated in the long run by holding back the energy from the radiator in a manner forcing the radiator to convert it into electric waves at the pace or rate set by the persistently oscillating lateral circuit.

The following paragraph of the specification, lines 25 to 38, inclusive, page 2, relates the operation of the transmitting system to obtain the requirements set for it by Marconi in the paragraph I have just quoted. The operation is stated as follows:

"In operation the signaling-key *b* is pressed, and this closes the primary of the induction-coil. Current then rushes through the transformer-circuit and the condenser *c* is charged and subsequently discharges through the spark-gap. If the capacity, the inductance, and the resistance of the circuit are of suitable values, the discharge is oscillatory with the result that alternating currents of high frequency pass through the primary of the transformer and induce similar oscillations in the secondary, these oscillations being rapidly radiated in the form of electric waves by the elevated conductor."

This quotation describes the manner in which the condenser *c* of the lateral circuit receives a quantity of electrical energy from a source of supply to be converted into high frequency electrical currents or oscillations. It makes clear that the spark gap is a trigger device which holds back the electrical energy from flowing in the circuit until the condenser has been supplied with a quantity of energy, and also makes clear that the spark gap is not in itself the producer or generator of the desired oscillations, for it states that whether or not the discharge is oscillatory depends upon the capacity, the inductance, and the resistance of the circuit having suitable values. Marconi points out that with suitable values for these characteristics the discharge is oscillatory resulting in high frequency alternating currents passing through the primary of the transformer. He points out that the passage of these high frequency oscillations of the lateral circuit through the primary of the transformer induce similar oscillations in the secondary circuit or elevated conductor, where they result in radiation in the form of electric waves. That is, Marconi used the lateral circuit as a generator or source of oscillations of definite characteristics, and having produced these oscillations of definite characteristics, he impressed them without change in characteristics ("similar oscillations") upon a circuit designed or arranged to well impart the energy of these oscillations definite in characteristics to surrounding space.

Having provided for a source of oscillation of definite characteristics, Marconi then gives some instructions for obtaining best results from these oscillations. The paragraph immediately following the one just quoted, that is, lines 39 to 49, inclusive, page 2, reads as follows:

"For the best results and in order to effect the selection of the station or stations whereat the transmitted oscillations are to be localized I include in the open secondary circuit of the transformer, and preferably between the radiator f and the secondary coil d' , an inductance-coil g , Figure 1, having numerous coils, and the connection is such that a greater or less number of turns of the coil can be put in use, the proper number being ascertained by experiment."

That is, for best results it is not sufficient to impress the oscillations which he generated upon any elevated conductor that happened to be available, but upon one including a variable inductance coil, so that a greater or lesser number of turns of the coil could be put in use, the proper number of turns being ascertained by experiment. This, of course, simply means that Marconi varied the inductance in the elevated conductor until the product of the inductance and the capacity inherent in the structure of the elevated conductor was of such value as to give the elevated conductor system a natural period of electrical oscillation in resonance with the frequency of the oscillations produced in the lateral circuit. Having arrived at such adjustment there would be a better and more efficient absorption by the elevated conductor circuit of the energy in the magnetic field produced by the oscillations or currents passing through the primary winding of the oscillation transformer $d d'$. This would be manifested by currents of larger amplitude or greater intensity flowing in the elevated conductor circuit. Again, if the elevated conductor circuit were not adjusted in its natural period to be the same as that of the frequency of the oscillations in Marconi's generator, the lateral circuit, there would be oscillations of two frequencies in the elevated conductor. One of these oscillations would have the frequency of the oscillations in the lateral circuit. The other set of oscillations would result from some of the energy absorbed by the elevated conductor circuit changing its frequency of movement to the natural period of the elevated conductor. Another good reason for adjusting the natural period of the elevated conductor circuit to resonance with the generated oscillations is that the generated oscillations are rapidly expending their energy in various ways, some of them a total loss. If the elevated conductor circuit where the energy is to be usefully utilized

is not made as receptive or as good an absorber as possible by the time the oscillations in the lateral circuit have ceased, the elevated conductor will have received a portion only of its maximum possible share of the available energy.

The specification next proceeds to a consideration of the receiving stations, and offers for selection as preferred forms a number of receivers described by Marconi in several United States patents, patents Nos. 586193, 627650, 647007, 647008, 647009, and 668315 being specifically mentioned. The specification also suggests as a responder to electric waves, or detector, the use of the coherer described in Reissue patent No. 11913 (original No. 586193), here in suit, which has been fully described in connection with the consideration of the reissue patent; or the specification states that other well known devices may be used, naming a number developed subsequent to the early Marconi patent.

The specification next proceeds with a number of suggestions for varying the capacity or the inductance, or both, in the two circuits at the receiving station for placing the receiving system in resonant accord with the transmitting system, describing the various variable elements for accomplishing these adjustments, the detailed description [fol. 712] being concluded with the following general statement, lines 12 to 17, inclusive, page 3:

"The adjustment of the self-induction and capacity of any or all of the four circuits can be made in any convenient manner and employing various arrangements of apparatus, those shown and described herein being preferred."

That is, the art had already devised convenient ways of adjusting the inductance and capacity of electrical circuits, and Marconi was not insistent upon the use of any particular manner or way of accomplishing this adjustment.

The specification is then given over to a detailed description of the manner in which Marconi built a number of the elements of his system, and on page 4 includes tables for six different tunes of his transmitting and receiving stations, the tables specifying which of the elements he has previously described in detail are to be used for each one of the tunes.

The following paragraph in the specification, lines 118 to 129, inclusive, page 2, refers to the system as a whole, including both the transmitting and receiving stations. It reads:

“The capacity and self-induction of the four circuits—i. e., the primary and secondary circuits at the transmitting station and the primary and secondary circuits at any one of the receiving stations in a communicating system—are each and all to be so independently adjusted as to make the product of the self-induction multiplied by the capacity the same in each case or multiples of each other; that is to say, the electrical time periods of the four circuits are to be the same or octaves of each other.”

That is, having provided a system capable of resonance, one having a single frequency generated in and set by the first circuit into which energy is introduced at the transmitting station for conversion into high frequency electrical oscillations, namely, the lateral, energy-conserving, persistently oscillating circuit at the transmitting stations, the proper thing to do is to adjust the time period of all of the other circuits in the system to that of the pace setting or frequency determining circuit.

Referring to the use of the system for localizing the transmission of intelligence, the specification states, lines 5 to 11, inclusive, page 3, the following:

“If the time periods of the circuits of the transmitting station are varied until they are in resonance with those of one of the receiving stations, that one alone of all of the receiving stations will respond, provided that the distance between the transmitting and receiving stations is not too small.”

This points out that the time periods of the circuits of the transmitting station are to be varied until in resonance with but one of the receiving stations. This does not merely mean adjusting the product of inductance and capacity, but includes adjusting the transmitting station so that it is capable of producing resonance in but one of the receiving stations. This requires producing waves of but a single frequency which are sufficiently drawn out to permit of a receiving station being resonantly affected thereby. When waves having such characteristics are produced, then advantage may be taken of adjusting the individual time [fol. 713] periods of the circuits to this one-frequency, long drawn out wave, and it is only by such provision that one receiver can be affected to the exclusion of others.

In the foregoing I have considered the various statements of Marconi as to the objects of his invention, its differences from prior radio systems, his discussion of how the system should function, his statements of operation, and some of the details of construction of the various elements. With these matters in mind, it is most clear to me that Marconi provided a particular and most definite system for radio communication, founded on the basis of creating in the lateral circuit at his transmitting station electrical currents or oscillations of a fixed and unchanging frequency, backed up by a sufficient initial supply of energy and conserved through a proper coordination of the elements of the lateral circuit, and delivered to an associated radiating circuit, all such that the oscillation while maintaining their constancy of frequency would be persistent or maintained for a long time in order that all of the mediums between the lateral circuit, the first circuit of the system, and the lateral circuit at the receiving station, the last circuit of the system responsible for transferring the electrical energy from one stage to another in the system could be caused to accomplish this transfer through what might be termed "cumulative resonance." The mediums of transfer of the high frequency energy from the beginning to the end of the system are, first, the magnetic field created by the currents flowing in the primary winding d of the oscillation transformer $d d'$; second, the currents flowing in the elevated conductor A , which currents are created by the action of the magnetic field on the secondary winding d' ; third, the electrical pressure variations or waves in space, which variations are created by the currents flowing in the elevated conductor A ; fourth, the currents flowing in the elevated conductor A at the receiving station, which currents are created by this conductor absorbing or having impressed upon it some of the energy in the space waves or electrical pressure variations; fifth, the magnetic field created by the received currents flowing through the primary winding j' of the oscillation transformer $j' j^2$ at the receiver; sixth, the currents flowing in the lateral circuit at the receiver due to the effect of the magnetic field created by the currents in the primary winding j' upon the secondary winding j^2 . Unless the frequency of all of these high frequency currents, magnetic fields, and electrical space pressures or waves is one and the same throughout the entire system, and sufficiently long

drawn out or enduring, there can be no real cumulative resonance, or as Marconi terms it, localizing of electric waves from a transmitting station at any one selected receiving station.

It is well known that in transferring alternating-current energy from one circuit to another through any form of interlinkage of the two circuits there results a conversion of the one frequency of the alternations which exists with-
[fol. 714] out any interlinkage with another circuit into alternations of two frequencies, one higher than the frequency existing with no interlinkage and one lower than this frequency, and that the no-interlinkage frequency no longer exists unless the two circuits are so loosely interlinked that the affect of the second circuit drawing energy from the first circuit is very small. This interlinkage of two circuits is commonly termed "coupling," and the two frequencies resulting from the interlinkage or coupling are termed generally "coupling frequencies." It is common to say that if the two circuits are so loosely interlinked as to create no apparent two frequencies from a practical point of view, that the circuits are "loosely coupled." If the interlinkage is such as to create two frequencies sufficiently widely separated as to be detectable with practical radio receiving apparatus the circuits are said to be "tightly coupled."

This formation or development of two coupling frequencies is not and can not be controlled by adjusting the product of the capacity and self-inductance of each of the two circuits considered independently to the same value. The control in this respect is entirely through the degree of interlinkage, or, as commonly expressed, "degree of coupling" between the circuits. It has been frequently stated in this case that the frequency with which electrical energy will oscillate in an oscillatory circuit when the circuit is charged with electrical energy which is set free to move, depends upon the values of capacity and inductance in the circuit. This means that this is true only when the circuit is considered independently and uninfluenced or unhampered by an interlinkage with another circuit. It is apparent that the moment another circuit is brought to bear upon an oscillating electrical circuit so that it absorbs energy therefrom, the moving energy no longer can deal only with the capacity and inductance of the first circuit but has to encounter and take into consideration the ca-

capacity and inductance of the second circuit, the extent of the affect of the second circuit upon the first circuit being dependent upon how closely the two circuits are interlined or coupled. The bringing to bear of the second circuit on the first circuit will first have the effect of drawing energy from the first circuit or placing a load on it, and the electrical energy under such load will tend to slow down in its rate of motion. The second circuit having drawn some energy from the first circuit will then, through the interlinkage or coupling, try to give back some of the energy with the result that the movement of the energy is accelerated. This is a condition not limited to electrical circuits alone or high-frequency circuits, but is commonly encountered in electrical machines. For instance, a generator driven by a turbine or engine will deliver energy to a motor connected in the line which put a load on the turbine or engine, and the turbine or engine will tend to slow down unless there is provided a governor to open the throttle wider and admit more steam under such conditions to maintain the speed constant. The motor having received energy from the generator will increase its speed and under this increase generate a higher back electromotive force, which will tend to return some of the energy taken by the motor back to the generator and permit the generator to speed up above normal speed, unless the governor again comes into play, and closes the throttle to admit less steam to the driving element. Likewise, this holds true in the case of two oscillatory bodies, such as stretched strings or pendulums. [fol. 715] We know that a pendulum by itself will oscillate at one frequency. However, if we attach it to another pendulum as through a rubber band, it will change from its normal or natural frequency of oscillation to two frequencies, and these two frequencies will be close together or widely separated, depending upon how closely the two pendulums are interlinked, as by whether or not the rubber band is large and stretches with difficulty or is small and stretches easily. In the case of a large rubber band, the two pendulums would be tightly interlinked or coupled, the effect of the first pendulum on the second pendulum would be large, and the frequencies of oscillations would be widely separated. In the case of the small rubber band, the effect of the first pendulum on the second pendulum would be small, the two pendulums being under such circumstances

loosely interlinked or coupled, and the two frequencies would be very little separated, and if the rubber band is made sufficiently elastic, it would be quite difficult to note any difference between the two frequencies, or between either one of the two frequencies and the uninfluenced frequency oscillation of the first pendulum.

Still considering the pendulum analogy, if the rubber band is large and does not stretch easily, it is easy to visualize that the tugging of the second pendulum on the first pendulum will very soon absorb the energy from the first pendulum to the benefit of the second pendulum, and then the second pendulum having all of the energy proceeds to reverse the situation and the tugs on the first pendulum until finally the first pendulum has all of the energy that remains, some of it being dissipated of course in mechanical and air friction and in molecular displacement friction in the rubber band, and this transfer of energy from the one element to the other goes on alternately until all of the energy is expended and the two pendulums are at rest.

If the two pendulums tightly coupled through the large rubber band are not of the same size—that is, one large and the other small, so that they do not have the same natural frequency of vibration—it is still easy to see that the tugging of one on the other will tend to transfer the energy back and forth between the two elements just as would happen if they were exactly the same. However, it would take the small one a long time to get all of the energy away from the big one, and the big one would have all of the energy of the small one in a very short time. This merely results in an irregularity in the instances in which the energy is first all in one, and second, all in the other, and it would naturally be difficult to determine just when these instances would occur, the determination depending upon a number of complicated considerations, such as the relative masses of the two pendulums and the elasticity of the rubber bands connecting them. If the two pendulums are exactly the same, it will take the same length of time for each one to extract the energy from the other, so that under such circumstances the instances when the energy being all in one and entirely absent in the other are more easily predicted and more readily under control.

(Recess.)

[fol. 716] The larger the rubber band, or the less the elasticity, the greater will be the effect of the tug or pull of one pendulum on the other; that is, the greater will be the transfer of the energy of the one pendulum into the other for each oscillation, and therefore it will require fewer oscillations to have all the energy passed from one to the other, thus increasing the frequency of the instances when the energy is all in one and entirely absent from the other, and vice versa. This means that the frequency of these instances is entirely under the control of the interlinkage or degree of coupling between the two pendulums, or any other analogous system, such as oscillatory electrical circuits.

If we make the rubber band small, that is, of large elasticity, it is easy to visualize one pendulum completing practically its entire swing without imparting much energy to the second pendulum and without having its motion greatly disturbed either as to frequency or extent. Under such circumstances, it would take a great many swings of the first pendulum to set the second pendulum into large motion, so much so that the energy derived from the motion of the first pendulum may be entirely expended in friction and otherwise in both pendulums before the second pendulum can ever accomplish acquiring all of the energy common to the coupled system, and there will not occur instances in which the energy is first all in one pendulum and then in the other. Under this condition of loose coupling the oscillations or swings of the pendulum endure longer than under a condition of tight interlinkage or coupling. The energy wasted or expended depends upon the extent or amplitude of oscillation of the two pendulums. If the energy is quickly transferred in large amounts from one to the other, both move through greater distances or amplitudes and expend energy rapidly. If only one moves through great distance and the other through small distance, as in the case in loose coupling, only one is rapidly expending energy and therefore the oscillations can endure for a much longer period of time. In the loose coupling when the first pendulum starts its action on the second pendulum there is at first a building up of the extent of swing of the first pendulum starting from no motion at all. Having little motion to begin with, the second pendulum does not expend much energy and the energy derived from the first pendulum can mostly all be employed in

building up the swing until finally the swing reaches such extent that the energy expended is just made up by that derived from the first pendulum. At this point the extent of swing ceases to increase, and since the first pendulum has expended a fair portion of its energy in arriving at this point it can no longer supply the same amount of energy to the second pendulum, and from this point on the extent of oscillation begins to decrease. If the first pendulum is so constructed as to originally receive and store a large amount of energy, is designed to conserve this energy, and is interlinked with the second pendulum so that it slowly transfers energy, then the oscillations endure or are maintained for a long time. These same considerations apply in interlinking electrical oscillatory circuits to cause the oscillations to endure or be maintained for a long period of time.

With the two pendulums interlinked through the small rubber band, if one is larger than the other, it is readily [fol. 717] apparent that the second pendulum having received some energy from the first pendulum will endeavor to oscillate at its own natural frequency, or period of vibration. At the same time, it is always being pulled or tugged at by the first pendulum through the rubber band at the frequency of the first pendulum. There will result a complex motion having two frequencies, one, that of the first pendulum, and, second, that of the natural period of the second pendulum. Under such circumstances, there will not be the same extent of motion of the second pendulum, part of the energy received being bent upon one purpose and part of the energy upon another purpose. If the second pendulum is made to have exactly the same natural period as that of the first, then these two energies are brought together to a common purpose, that of creating swings of one frequency, with the result that the extent or amplitude of swing is substantially increased.

This discussion, I think, makes clear that energy to be usefully utilized must be directed in one path toward one purpose, and not spread out over a number of paths of effort having conflicting purposes. In the language of Marconi, this is merely "localizing" effort. It also makes clear that if it is impossible to localize effort through quick action, then much can be gained by taking a little more time to acquire practically perfect localizing of effort, and though the action of each localized effort may be small,

when added together over a long period of time, a better result may be obtained than through two strong, non-localized efforts acting to different purposes.

This discussion has shown that a prime factor toward localizing of effort in transferring energy from one system to another, whether the system be electrical or mechanical, is small interlinkage or loose coupling. The Marconi specification does not go directly into the matter of loose coupling between his circuits, but I think, taking together all that he says, it is impliedly contained in the language of the specification. He positively states conditions that must obtain for the success of his system, and these conditions can not be obtained without due consideration for the laws governing coupled energy transfer systems.

His main object is the localizing of the energy effort of his system, and I have shown that this can not be accomplished in a coupled system without making the coupling loose. He states that the oscillations must be long drawn out or maintained for a long time. The laws of coupling make this impossible without loose coupling. He states at the transmitting station the oscillations transferred into the elevated conductor or good radiator must be "similar" to those in the lateral circuit. I have shown that the laws governing coupled systems make this impossible without loose coupling. There is therefore language in the Marconi specification which to one skilled in the art beyond all doubt implies a proper degree of loose coupling.

Aside from the language, this is very definitely indicated in the drawing to one capable of interpreting the ordinary conventional way of indicating or illustrating electrical circuits. In Figure 1 there is shown a single turn of wire representing the primary d of the oscillation transformer $d d'$, and only two turns of wire representing the secondary, d' of this transformer. The turn d is turned away [fol. 718] from the two turns d' , indicating a separation of the two elements of the transformer, separation or special relation being one way of reducing the degree of coupling in such a device. Also, where there are only one or two turns of wire, it is very difficult to get a tight coupling because the magnetic field is most intense immediately around the surface of the wire, and if the wire is insulated or separated from the turns of the other coil to prevent sparking the magnetic field escapes in the path represented by this insulation without linking with the wire of the other

circuit. The figure shows part of the turns of the inductance in the elevated conductor A located in the coil *g* so far removed from the primary *d* that the magnetic field originating in the primary *d* would not to any practical extent act upon the turns of the coil *g*. Since the degree of coupling depends upon the percentage of the total inductance of a circuit that interlinks with the magnetic field of the other circuit of the system, and since the drawing indicates four *turns* in the coil *g* only two turns in the coil *d*, there is indicated only a small percentage of the inductance of the elevated conductor A in a position capable of being at all effectively interlinked with the lateral circuit. An analysis of the tunes listed on page 4 of the specification with reference to the devices listed for accomplishing the tunes and described also in the specification shows that in practically all cases there was provided arrangements for a degree of coupling which in the practice of the radio art would be considered effectively loose for good localizing of energy effort.

The Marconi specification requires at the transmitting station a device which he terms a "spark producer" in several places and on page 2, line 30, a "spark gap." On page 1, lines 83 and 84, he describes this device as having "spherical terminals or other contacts." In the drawing, Figure 1, the device is unmarked, but is shown immediately to the left of the letter C as being two small balls separated by an airgap. In several places in the specification, I find language bearing upon the requirements for this device. Page 2, lines 9 and 10, Marconi states "circuit of the primary being a good conserver." Since the spark gap is one of the elements of the primary of the lateral circuit of the transmitter, it must be so designed as to aid or do its share in this circuit towards conserving the energy; that is, it must not be unreasonably wasteful.

Page 2, lines 12 to 20, as follows:

"My experiments have demonstrated that the best results are obtained at the transmitting station when I use a persistent oscillator an electrical circuit of such a character that if electromotive force is suddenly applied to it and the current then cut off electrical oscillations are set up in the circuit which *persist* or are maintained for a long time."

The spark gap being an element of the circuit which Marconi specified as a persistent oscillator, the gap must do its part in permitting persistency; that is, broken down from the high resistance which it had before the condenser *c* was fully charged, the gap must remain low in conductivity for a long time and not close too soon to stop the flow of oscillations. It must permit the oscillations in the primary circuit to "persist" or be "maintained for a long time."

Page 2, lines 30 to 36, inclusive, reads as follows:

"If the capacity, the inductance, and the resistance of the circuit are of suitable values, the discharge is oscillatory, with the result that alternating currents of high frequency pass through the primary of the transformer and induce similar oscillations in the secondary."

The resistance of the spark gap after it is broken down and becomes of low conductivity is part of the resistance of the circuit which it is desired to have oscillatory, and the resistance in the gap together with the resistance of the rest of the circuit must be such that oscillatory discharging of the condenser will be permitted.

With the above instructions from Marconi, it is easy to determine the character of the spark gap or spark producer required by his system. The first function of the spark gap is to retain the intended oscillatory lateral circuit open while the condenser *c* is receiving a quantity or charge of electrical energy from the source. The air gap between the balls or other electrode of the gap with a separation of only a fraction of an inch will prevent current from flowing across this gap with pressures as high as ten to twenty-five thousand volts, the voltage at which the gap will break down depending upon the separation between the balls or electrodes and upon their shapes. The separation of the electrodes therefore determines how much energy is put into the condenser *c*. The higher the voltage to which the condenser *c* is charged, the greater the quantity of electricity that is stored therein for a given capacity of condenser. In practice, it is usual to make the separation between the two electrodes of the gap adjustable, so that varying powers of transmission are obtainable. Air under ordinary conditions is a very good insulator or obstructor to the flow of electrical current, so that a spacing of a small fraction of

an inch between such electrodes ordinarily holds back the flow of current under voltages of the order of several thousand. Electrical sparks will more readily jump from pointed electrodes than flat or rounded ones, such as the balls, shown in Figure 1, and the jumping or sparking from pointed electrodes is more irregular as to voltage required than in the case of flat or round electrodes. Pointed electrodes also deteriorate more readily under the heat produced in the gap than electrodes of larger surface, and with pointed electrodes it would be necessary to adjust the gap length more frequently to take care of the burning away of the points. For this reason the ball or cylindrical rod types of electrode were very common in general practice.

The condenser *c* having received a charge of electricity up to a voltage or pressure predetermined by the separation of the electrodes of the spark gap, a spark jumps across the gap and in so doing changes the electrical characteristics of the atmosphere in the space so that instead of having a resistance of thousands of ohms, the resistance immediately falls to a very low value, allowing the condenser *c* to discharge causing a current to flow in the oscillatory circuit, finally charging the condenser to a high voltage in the opposite sense. This opposite sense charge causes a current to flow in the opposite direction, and since the rapidity of the change is such that the spark gap is not given opportunity to regain its normal state of high resistance, the current in the opposite sense also encounters a low resistance in the gap and so on until the oscillating energy reaches such a low value that the gap is allowed to recover itself from the effects of the passing current in the interval when no current is flowing at one of the reversals.

[fol. 720] Spark-gap action may be visualized by the common happenings in handling electrical switches, the difference of action between opening and closing electrical switches being undoubtedly familiar to everyone. In ordinary house lighting, the voltage on the line is about 110 volts. A switch on such a line can be closed without drawing the slightest sign of a spark. In starting to close the switch, the air separating the switch and the switch blade is normal and of high conductivity, and the switch can approach the blades to a very minute fraction of an inch without causing a spark to jump under the low pressure of 110 volts. On the other hand, if the switch is closed, and the

circuit carrying current, on opening the switch a current follows the switch as it is drawn away from the contacts ionizing or changing the character of the atmosphere separating the contacts and the blades with the result that a very long and intensive spark can be drawn. This means simply that the current flowing in the path is given opportunity to change the character of the atmosphere separating the two conducting elements, and changes this character from a very high resistance to a very low resistance. If the atmosphere having undergone this change can be swept aside or dispersed, the spark can be broken up. A strong magnetic field acting on such a gap will disperse this atmosphere, or a strong blast of air is to a degree effective. In general electrical power transmission it is customary to provide switches with a device which creates a strong magnetic field across the gap between the contacts when a switch is opened, this device being known as a "magnetic blow-out." Often switches in circuits carrying heavy currents are arranged to open in a body of oil rather than in air, oil being a good insulator and yet not having its character as to resistance changed so readily as air when a current or spark takes place.

This effect on the air or atmosphere in the space separating two electrodes when a current flows across the path is termed "ionization." This means that the electrical character of the atoms forming the atmosphere in the space is changed. Normally, the atoms of a gas are in a state of equilibrium or neutral in the matter of electrical characteristics. An atom is comprised of a definite number of electrons, and an electron may be said to be an infinitely small unit of negative electricity, but not so small that it does not have mass, and therefore bump into something else and leave its effect. If an atom comprised of a definite number of electrons is in some way robbed of one or more of its electrons or units of negative electricity, then this atom becomes positive with respect to both the negative electrons it has lost and to other atoms of the atmosphere, and since electrical bodies which are differently electrified or charged attract each other, the atom which, under its new electrical condition, is termed an "ion," commences moving toward some other atom, which has not been ionized, at the same time the atom moving toward the "ion," with the result that the two collide, and when this collision takes place addi-

tional electrons are knocked out of the ion, and some electrons are knocked out of the atom which collided with the ion. The result of this is that there is created another ion to go running about bumping into other atoms, and in about one-millionth of a second or less the whole space is a turmoil of ions and electrons bumping about.

[fol. 721] Every time an ion bumps an atom more electrons are set free or knocked out of the atom, and every time an electron collides with an atom or an ion additional electrons are set free. The electrodes of the spark gap are oppositely charged or have positive and negative potentials with respect to one another and with respect to the electrons and ions. The positive electrode attracts the negative electron. These electrons rush toward the positive electrodes at an extremely high velocity, encounter atoms and ions on the way and colliding with them set free additional electrons to be drawn toward the positive electrode. The additional electrons also collide with atoms and ions on the way and further increase the effect. The ions, being positive, are drawn in an opposite direction to the movement of the electrons toward the negative electrode of the gap. The ions being of greater mass than the electrons do not travel so fast, but their motion is opposite to that of the electrons, and aids in increasing the collision effect with the electrons. The ions on reaching the negative electrodes have considerable velocity and colliding with the negative electrodes suffer the loss of additional electrons through this collision, at the same time knocking electrons free from the atoms comprising the electrode structure. It will thus be seen that the space becomes a very active neighborhood, and this is manifested in the form of a spark which gives off light, noise and heat, a phenomenon familiar to every one who has seen a spark drawn in any form of electrical circuit, or a spark jumping from clouds to earth in the familiar form of lightning.

Electrical current is merely the movement of electrons, the amount of the current being a measure of the number of electrons in motion. Electrons can move through solid bodies such as wires, and in fact moves very readily and with the least resistance in certain solid bodies such as copper and silver. They can also move through gases, such as air, but do not start to move so readily as in solid bodies until a few of them are set at a high speed motion to knock

other electrons out of the atoms of the gas to establish a flow of electrons. It takes a very high voltage to start this collision effect, but once started, the voltage to maintain it need be but very small. For instance, in the spark gap, they may remain inactive up to voltages of ten to twenty-five thousand depending upon the length of the gap, but once a sufficiently high voltage is reached to start a few collisions, or movement of electrons and ions, the voltage immediately falls. This is the same as saying that the inactive gap has a high resistance, and in fact the resistance is the order of thousands of ohms. Immediately the collision effect takes place the resistance falls to a very small value, a mere fraction of an ohm.

It is this resistance of the gap in its broken down or active state that Marconi is interested in from the point of view of one of the requirements of his lateral circuit, the one stated at line 10, page 2 of the specification, which is that the lateral circuit must be "a good conserver" of energy. If the active or broken-down resistance of the gap is unnecessarily high, an unnecessary amount of energy will be wasted [fol. 722] in the gap detrimental to conservation of energy. There are arrangements of gap lengths, shape of gap electrodes and material of electrodes, as well as atmosphere between the electrodes which determine whether or not resistance of the gap during the active state will be unnecessarily high or desirably low. As to gap length, the greater the energy which can be stored in the charging condenser, the greater the current that will flow in the circuit when the gap breaks down. The longer the gap length, the greater will be the energy storage in the condenser. The larger the current flowing in the gap the more intensive is the resulting ionization, which means lower gap resistance. Therefore, one suitable requirement for the Marconi gap is long gap length. As to gap electrode shapes, the more the electrodes depart from the sharp or pointed form the less the gap resistance. Spherical balls or flat-shaped disks are better than sharp-pointed electrodes. Balls of large radius are better than small balls. This is readily apparent from the consideration that the ionization between pointed electrodes would be restricted to a path of small area of cross section. If the electrodes are spread out there will be a path for ionization of large cross section. This follows the general law of movement of all kinds of matter. The bigger the path in which anything has to flow the less the

resistance to the flow. As to material, there are certain materials which do not substantially aid in the ionization effect, such as copper and silver, while there are others which play quite an important part in the ionization, such as tin and zinc. These latter named materials readily vaporize under heat, and since there is considerable heat generated in a spark gap, electrodes of tin and zinc furnish metallic vapors to the atmosphere in the path. Metallic vapors more readily and more intensively ionize than do ordinary gases. There are therefore added two other suitable arrangements for meeting Marconi's requirement for good conservation, namely, electrodes for the gap having lateral extent such as balls or disks, and electrodes of vaporizing material. A very common form of spark gap was one having disks of zinc for the electrode. As to the atmosphere of the gap, I have pointed out that atmosphere of metallic vapors originating from electrodes of suitable material assisted in reducing gap resistance. Air is better than hydrogen or other gases having less atomic weight than air, and the general practice has been to operate the gap in air.

On account of the heat generated in the gap aiding in the vaporization of the metallic electrodes, it is not desirable for low resistance to make any special provision for cooling the gap provided the heat generated is not so intensive as to destroy the gap at such a rate as to make frequent renewals necessary. In handling extremely large powers the consumption of the gap electrodes would be rather rapid without some arrangement for cooling, and under such circumstances a compromise has to be made with the matter of obtaining the best possible low resistance. I have also previously stated that ionization could be affected by dispersing or diffusing the ionized atmosphere between the electrodes, such as the use of a magnetic blow-out, common to switches in power lines. Such a device would act against obtaining low resistance in a spark gap and has never been used to my knowledge in a spark-gap radio transmitting system.

[fol. 723] The second requirement by Marconi for the lateral circuit at the transmitting station is stated page 2, lines 18 to 20, inclusive, as follows:

"Electrical oscillations are set up in the circuit which persist or are maintained for a long time in the primary circuit."

This in effect states that there must not be permitted any too early unnecessary stopping or interference with the oscillations in the primary circuit; they must persist or be maintained for a long time. This has bearing upon what the spark gap must be, for if it is not correctly or properly designed, it will return to the inactive high resistance state too early and stop all oscillations in the primary circuit, leaving a residual unexpended charge of electricity in the condenser c , and there will be no real benefit gained by giving this condenser an initial high charge. In addition to the oscillations not being maintained for a long time, the circuit would not be the desired reservoir of energy for the radiating circuit, for with an early cut-off of the gap, the residual charge of electricity stowed in the condenser c could not be made available to the radiating circuit. It only is made available through the motion of the electrical energy, as when in motion it passes through the primary coil of the oscillation transformer to create a magnetic field, and it is from this magnetic field that the secondary circuit gathers its energy for radiation.

Some of the features of construction determining whether the spark gaps will close or become inactive early, or remain active for a long time, are (1) length of the gap, (2) nature of the materials forming the gap electrodes, (3) shape of the gap electrodes, (4) atmosphere between the electrodes, and (5) cooling the electrodes.

As to gap length, this is best understood by considering the nature of the oscillations, and the current magnitude accompanying the oscillations. First, the current flows in one direction, gradually building up until it becomes a maximum. Then the current begins to subside until it reaches a zero, or no value, there being no current at all. Then the current proceeds to flow in the opposite direction building up to a maximum, followed by a subsiding to no value, and this cycle of events repeats itself, the maximum amplitude of the current always being a little less for each successive oscillation on account of the energy given to the radiating circuit and the energy expended in losses. The oscillations are extremely rapid, the ordinary spark radio transmission being of the order of half a million per second. There are two periods of no current value for each cycle of events, so that for one-half million cycles per second, there will be one million instances of no current value. The instances

of no current value of course are a very small part of the duration of a cycle of events, so that in one-half million cycles per second the duration of the instant of no current value would be figured in the order of one-billionth of a second. If the gap is going to be deionized and become inactive it must do so during the time that no current is flowing, and of course must be extremely quick in accomplishing this in the very short interval of time that it has. When the current reaches its zero value some of the electrons and ions are left near the center of the gap space, and if these ions and electrons can get to the electrode before the current commences in the opposite direction there will be no ionized path for the new current to start on and the gap will remain inactive. If the gap length is short the electrons and [fol. 724] ions may succeed in accomplishing this, but if the gap length is long they cannot travel the distance in the very short interval of time available. Therefore, persistency or maintenance of oscillations for a long time depends upon length of gap.

As to nature of material forming the gap electrode, I have pointed out that certain materials such as tin and zinc vaporize and furnish metallic vapor to the atmosphere in the gap. The atoms of these metallic vapors are much heavier than the atoms of gases such as hydrogen and air, and therefore under the same moving force travel at a much lower rate. Ionized atoms of such vapors left near the center of the gap have much less chance of reaching the gap electrodes during the minutely small interval of no current than have ionized atoms of light gases. The material of electrodes therefore plays an important part in maintaining the oscillations for a long time, and zinc has been a very common material for the electrodes.

As to the shape of the gap electrodes, the greater the extent of the surface of the electrode the better the opportunity the ionized atoms in the path have for reaching the electrodes, as there will be many paths of entrance towards the electrodes instead of all trying to crowd into one point of entrance as would be the case in pointed electrodes. While electrodes of large extent are desirable for low resistance, they aid in causing an early opening of the gap, and for this reason the early art adapted a sort of compromise in this particular arrangement. The gap electrodes were neither pointed or of very large extent.

As to atmosphere between the electrodes, I have already stated the beneficial effects of metallic vapors over lighter gases, and have pointed out the use of vaporizing material for the electrodes. Light gases like hydrogen or helium have atoms of small mass or weight which would travel very rapidly to the electrodes as compared to air, the atomic weight of air being some sixteen times that of hydrogen and a number of times that of helium. It has been common in the practice to use these gaps in air, from which use they derived the name of "open gap," so generally applied to them.

As to cooling of the electrodes, I have pointed out that heat is necessary for generating the metallic vapors, which are beneficial for maintaining the gap active for a long time. In the use of these open gaps, the art has not resorted to cooling means, except where very large power is used, resulting in too rapid a consumption of the gap electrodes. The heat is also beneficial from another point of view. Heated bodies throw off electrons, and with electrodes heated during the period of no current flow, the heated electrodes continue to throw electrons out into the gap space, leaving some electrons available to start the new current flowing.

I neglected to include in the list above deionization by artificial diffusion, such as a magnetic blow-out. A magnetic blow-out will greatly aid in clearing the path between the electrodes of ionized atoms during the interval of no current, and such deionization would aid in rendering the gap inactive and stopping oscillation. No such devices have been adopted by the art.

[fol. 725] I have prepared a number of sketches in which I explain the manner in which coupling between two oscillatory electrical circuits may be obtained, the effect of various types of coupling upon the frequency of the oscillations and also the effect of making the time period of each of the two circuits considered independently the same—that is, making the product of the capacity and self-inductance of each of the two circuits the same. In these sketches I have used colors to represent in the various figures different frequencies. I have selected purple to represent the desired frequency for localizing radio signals at a receiving station. I have selected red and green to represent the two coupling frequencies obtained when the coupling is close, red rep-

representing the coupling frequency which is greater than that of the desired frequency and green representing the coupling frequency which is less than that of the desired frequency.

In the practical application of radio to communication both for short distances and long distances it is necessary to assign different frequencies to different types of communication in order to minimize interference and in order that receiving stations may know how to adjust their receivers when expecting a communication from a transmitting station required by the rules to transmit on a particular frequency.

Until the last year or so it was common to state these assignments in terms of wave length rather than frequency, but the tendency now is to state the assignment in terms of frequency, the unit being kilocycles, which is 1,000 cycles per second. The range of frequencies employed in modern radio is very wide; for instance, amateurs are restricted to a frequency in the neighborhood of one and a half million cycles per second, or 1,500 kilocycles, which in the old way of stating the assignment was a wave length of 200 meters, while the Lafayette radio station in France, the highest powered radio station in the world and the one employing the lowest frequency, has a frequency of about 15,000 per second, or 15 kilocycles, which in the old way of stating the assignment, was a wave length of about 20,000 meters. The intermediate frequencies between these two extremes are assigned for various purposes such as the popular broadcasting of to-day, communication between ships and shore stations, communications for the operation of radiocompass stations, giving bearings to ships at sea, the transmission of time and weather reports, communication between land stations and air craft, naval and military communications, short-distance point to point traffic between stations on land, and transoceanic communication for international use.

It is therefore seen that frequency is a *vital* characteristic in radio communication, and the great problem of the world to-day is that there are not sufficient frequencies to meet all of the requirements. International conferences have been held and future ones planned in the hope that through common understanding and agreement the frequencies so far made available through the development of the art up to date may be the most efficiently utilized. /

[fol. 726] It has always been particularly important in the practice of the art that a station when assigned a particular frequency should be able to create that frequency and should minimize to the greatest extent interferences with other frequencies due to impure wave forms and the like.

In my sketch marked "Loftin Sketch F" I have shown in Figure 1 a generator of high-frequency electrical currents or oscillations, the same as that described by the Marconi patent in suit, it being the lateral circuit of the Marconi transmitter illustrated in Figure 1 of the drawing of the patent. The generator A, which is the source of energy supply for the transmitter, is shown as an alternating current dynamo, and in ordinary practice would generate alternating current of from 60 to 500 cycles per second at a voltage of from 110 to 220 volts. The transformer C is an ordinary type suitable for stepping up the voltage from a comparatively low-frequency source to 10,000 to 25,000 volts, providing a high-voltage low-frequency source of supply for charging the condenser *e* with a quantity of electricity. The spark gap G is adjusted in length such that when the condenser E obtains a charge of electricity that will raise the pressure to 10,000 to 25,000 volts the gap will break down and allow high-frequency electrical currents or oscillations to take place in the circuit comprising the condenser *e*, the inductance coil *d*, and the spark gap G. Since this oscillatory circuit is not associated with any other circuit, the oscillations therein will be on one frequency, this frequency being determined by the product of the capacity of the condenser *e*, and the inductance of the coil of wire *d*. The mathematical formula for this relation between frequency and product of capacity and inductance is old, having been developed considerably prior to Marconi's work in radio, as I have pointed out in my discussion of the Lodge patent here in suit, and is as follows:

$$N = \frac{1}{2\pi\sqrt{LC}}$$

where N represents frequency, L inductance, C capacity, and π has the numerical value 3.1416. This formula is known to every worker in the radio art, but I refer to Wireless Telegraphy, by Zenneck, as translated by Seelig, 1915 edition, published by McGraw-Hill Book Co. (Inc.), New

York, in which on page 5 this formula is stated. Professor Zanneck, of Germany, the author of the publication, is accepted internationally as one of the leading authorities on the subject.

The oscillations of one frequency in the circuit of Figure 1 of my sketch F, passing through the coil d will create a magnetic field surrounding the coil of the same frequency of oscillation, and I have indicated such a magnetic field by a series of lines in purple, as representative of the so-called magnetic lines of force existing in such a field. I have illustrated these lines in purple because the circuit being uninfluenced by association with any other circuit, adjustment can be obtained such that there will be but one frequency, and this can be made the desired frequency or frequency assigned to the transmitting station. In Figure 1a I have made a view looking down through the coil d to illustrate how the lines of force of the magnetic field originate within the coil and extend radially in all directions.

[fol. 727] In Figure 2 of sketch F I have shown the effect of associating an oscillatory circuit such as illustrated in Figure 1 with another circuit through an interlinkage of coil d with a coil d' in the second circuit. The second circuit is illustrated as including an elevated conductor f , grounded to earth at E, as in Figure 1 of the Marconi patent. The two coils are shown in very close relation, the turns of one coil interleaving with the turns of the other coil, which would result in a very close or tight coupling, and would be the same as the two-pendulum system I have heretofore described when the two pendulums are interlinked through a large rubber band. I have explained that any two systems interlinked through a tight coupling will not result in oscillations of one frequency, but there will be oscillations of two frequencies, one being higher than the desired frequency and one being lower than the desired frequency. The magnetic field produced by the oscillations with two frequencies will also have two frequencies, and I have illustrated this by the red and green lines representative of the so-called lines of force of the magnetic field in the coils d and d' . Since the energy of the oscillations is divided between two frequencies, it can not be as strong in either one as it would be in the case of a single frequency as obtained in Figure 1, and I have indicated this roughly by making the extent of the red and green magnetic field

in Figure 2 less than the one-frequency purple magnetic field in Figure 1.

In Figure 3a I have shown a view looking through or down upon the coils D and D'. This view shows that practically all of the magnetic lines of force interlink both coils, and since the degree of coupling or tightness depends upon how many of the lines of force originating in one coil interlink with the other coil, this figure illustrates a very tight coupling.

Figure 3 is a modification of Figure 2, showing the coil *d'* somewhat separated from the coil *d*. Under such circumstances there could still be what in practice may be considered a tight coupling, as a great many of the lines of force originating in the coil *d* interlink or cut the coil *d'*. There would still result two decided frequencies of oscillation, and therefore two frequencies in the magnetic field, and I have illustrated this by coloring the lines of force of the magnetic field with red and green.

Figure 3a is a view looking through or down upon the coils *d* and *d'* of Figure 3, and shows how many of the lines of force of the coil *d* do not pass through or cut the coil *d'*, resulting in a much weaker coupling than that illustrated in Figure 2. The two frequencies resulting from the arrangement shown in Figure 3, would not be so widely separated in frequency as in the case of Figure 2.

The production of these two coupling frequencies is also subject to mathematical expression thus :

$$N^1 = \frac{N}{\sqrt{1-K}}$$

$$N^2 = \frac{N}{\sqrt{1+K}}$$

where N^1 is the frequency above the desired frequency, which I have indicated by red lines in my figures, N^2 is the [fol. 728] frequency below the desired frequency, which I have indicated by green lines in my figures, N is the desired frequency, or frequency that would be had by one circuit uninfluenced by the other, which I have indicated by purple lines in my figures, and K is a quantity representing the degree of coupling or interlinkage between the two circuits. K is the percentage of the total number of lines of force produced interlinking with the second circuit, and is expressed in percentage such as 20 per cent, 50 per cent,

3 per cent, and so on. In Figure 2 the interlinkage is large, so that the percentage representing K would be large. Perfect or 100 per cent coupling between electrical circuits is impossible, no matter what precautions are taken, as many of the lines of force concentrate close to the surface of the wire making up a coil, and since the turns of the wire must be somewhat separated to provide for insulation to prevent sparking, many of the lines of force escape in this insulating space without cutting the other coil. Couplings up in the 90 per cent are obtained in low-frequency transformers where iron cores are used to concentrate the magnetic field to one path, but in high-frequency circuits having no iron cores this high order of couplings is never obtained. Figure 3 well illustrates that the percentage value of K is fairly small, only a small percentage of the lines of force originating in the coils D , cutting the coil D' .

The two formulæ in the mathematical expression above show that there will be two frequencies under conditions of coupling which will vary from the desired or no coupling frequency by an amount depending upon the square root of 1 plus or minus the percentage of the coupling. As an example, let it be assumed that the desired frequency is 1,000 kilocycles per second, then these formulæ state that if the coupling is 20 per cent, instead of having a frequency of 1,000 kilocycles per second, there will be two frequencies, one of 1,112 kilocycles per second and the other of 913 kilocycles per second, which is a separation of 200 cycles. On the other hand, if the coupling is loose, say 3 per cent, there will result two frequencies very close together—1,015 kilocycles per second and 986 kilocycles per second, a total difference of 29 kilocycles. In the case of the 20 per cent coupling, a practical radio receiver will differentiate between the two coupling frequencies. In the case of the 3 per cent coupling, it will require an unusual receiver to differentiate between these two frequencies. The result is that for a coupling of 3 per cent there could for all practical purposes be considered to exist but one frequency, the average of the two frequencies, namely, 1,000 kilocycles per second. For the 20 per cent coupling practical apparatus would require dealing with two frequencies.

The formulæ I have stated above are also found in the Zenneck book I have just previously referred to, being the formulæ stated at page 88, article 59.

In Figure 4 of my sketch F, I have illustrated the coils d and d' of the two circuits as widely separated, so that only a very few of the magnetic lines of force originating in the coil d interlink with the link d' , resulting in a very loose coupling, so that for all practical purposes there may be [fol. 729] considered to be but one frequency, which I have illustrated by indicating the magnetic lines of force in purple. In the actual example above I have shown that if the interlinkage is such as to result in a coupling of 3 per cent, for all practical purposes there may be considered to be but one frequency.

In Figure 4a I have shown a view of coils d and d' of Figure 4, looking through the coils. The figure shows how, with the wide separation of the coils, there results a very small interlinkage of the two circuits as compared to Figure 3a, in which the coils are located close together.

In Figure 5 I have shown how loose couplings may be obtained by means other than separation of the coils of the oscillation transformer. In this figure the inductance of the two circuits is divided into two parts, part of the inductance in the lateral circuit being included in coil d and part in the coil g' . In the elevated conductor circuit part of the inductance is located in the coil d' and part in the coil g . In an arrangement of this kind the energy of the magnetic field is distributed over the several inductances in proportion to the inductance value of each of the coils. The only interlinkage between the two circuits is through the magnetic field of the coil d , and since this field is only a fraction of the total field, a large part of it being in the field of coil g' , the interlinkage between the two circuits is small. With this arrangement there may result such a loose coupling that for all practical purposes there may be considered to be but one frequency, and I have illustrated this by representing the magnetic lines of force of the several fields in purple.

In my sketch marked "Loftin Sketch G" I have illustrated some of the effects of coupling, using as before purple to represent the desired frequency, red to represent the coupling frequency above the desired frequency, and green to represent the coupling frequency below the desired frequency. I have also numbered the figures to correspond to the conditions illustrated in my sketch F.

Figure 1 represents the alternating current curve of the low-frequency dynamo in Figure 1 of sketch F, and I have

illustrated this curve in blue to differentiate from the colors I have already used for the high frequencies. As the current from the dynamo *a* reaches a maximum, such as near the point *x* on the blue curve, the condenser *c* is fully charged, and the spark gap *g* breaks down. There results oscillations of one frequency in the lateral oscillating circuit of Figure 1 of my sketch F, which I have illustrated as a train of oscillations in Figure 1*a* of sketch G. The strength of the oscillation is represented by the purple wave lines above and below the horizontal line, the portions above the horizontal line showing that the current first flows in one direction, and the portions below the horizontal line showing that the current next flows in the opposite direction, and so on. The train is shown as having strong oscillations to begin with, the oscillations gradually decreasing in strength as the energy is expended.

I have shown the blue curve representing the dynamo current in broken line from the point *x* to *y*, this on account of this current not following this line after the spark gap *g* breaks down. When the spark gap *g* breaks down, the current from the dynamo *a* immediately falls in value, and does not return to its normal form until the spark gap becomes inactive. I have shown the train of oscillations in Figure 1*a* as extending beyond the point *y* on the blue curve merely on account of space conditions on the drawing sheet. In actual practice, the train of oscillations ceases before the point *y* is reached, but to have illustrated this would have made it necessary to have crowded the oscillations into small space, making it difficult to illustrate them.

The current of the dynamo *a* is shown to commence building up in the opposite direction at the point *y* and to increase to a maximum to the point *z*, where the condenser *c* is fully charged in the opposite sense. The spark gap again breaks down and another train of high-frequency oscillations is created, this time the oscillations starting in the opposite direction from that illustrated in the first train, this on account of the condenser being charged in an opposite sense by the reversal of the current from the dynamo *a*. The blue curve illustrates the two maxima reached by the dynamo current during one cycle of events, and Figure 1*q* shows that there are two trains of oscillation created for each cycle of the dynamo *a*. That is, if the

dynamo *a* has 500 cycles per second, there will be generated or created 1,000 trains of oscillation per second.

I have illustrated the trains of oscillation in Figure 1*a* in purple, or of the desired frequency, as Figure 1 of sketch F shows a single circuit uninfluenced through association with any other circuit, and therefore a generator of but one frequency.

Figures 2, 2*a*, and 2*b* of my sketch G illustrate the conditions encountered under tight coupling as illustrated in Figures 2 and 3 of my sketch F. Figure 2 represents the oscillations in the lateral circuit and Figure 2*a* the oscillations in the antenna or elevated conductor circuit derived from the interlinkage of the two circuits. The figures also include the assumption that the products of capacity and self-inductance of the two circuits is the same. I have described how, under conditions of tight coupling, there results two frequencies, and so have illustrated the oscillations in both circuits in red and green. I have not shown the oscillations as extending as far above and below the line in these figures as in the case of Figure 1*a*, this on account of the energy being distributed between the two frequencies with the result that it will not be as strong in either one as it will be when there is but one frequency.

I have explained in connection with two pendulums connected by a large rubber band—that is, tightly coupled—that the energy of the first pendulum is gradually absorbed by the second pendulum, is given back to the first pendulum by the second pendulum, and so on. I have also explained that this action takes place in all coupled systems including electrical circuits. Examining Figure 2 it will be seen that the oscillations start strong but soon die down to practically zero at the point I have marked *p*. Examining Figure 2*a* it will be seen that the oscillations at first are weak, and gradually build up to a maximum at the point *p'* opposite the point *p*, or point of minimum energy in the lateral circuit. The antenna circuit having all of the energy at the point *p'* then gives back energy to the lateral circuit until at the point *q'* there is little or no energy in the antenna circuit and there is a maximum at the point *q* in the lateral circuit. This process continues on with the energy shifting from one circuit to the other, but always with two frequencies of oscillation, until all of the energy is expended, both by losses in both of the circuits and by radiation for signalling from the antenna circuit. At

some point in Figure 2 the spark gap g will become inactive, there being no longer sufficient energy to support ionization. There remains a small quantity of energy in the antenna circuit which will continue to oscillate, but since the lateral circuit is open and can not take energy from the antenna circuit to create two frequencies, the rest of the energy in the antenna circuit will oscillate at the natural frequency of the antenna circuit, which is the desired frequency under the conditions I have assumed of the product of capacity and induction being the same in both circuits. I have represented in purple at the end of Figure 2a the continuation of the oscillations at the desired frequency.

In Figure 2b I have plotted roughly the results on the energy radiated into space of coupling conditions creating oscillations of the type represented by Figures 2 and 2a. Horizontal dimensions represent frequency and vertical dimensions represent signal strength. The curve in green represents the signal strength radiated due to the coupling frequency less than the desired frequency. The curve in red represents the signal strength radiated by the coupling frequency greater than the desired frequency. The little curve between the red and green represents the signal strength radiated by the small amount of energy remaining in the antenna circuit when the spark gap becomes inactive, and this being of the desired frequency, is shown in purple. The figure shows that under conditions of tight coupling the energy radiated on the desired frequency is so small as to be of no practical value, while energy is radiated on two coupling frequencies quite strong.

The summary of this figure is that a receiver expecting to receive this transmitting station on a definite frequency and so adjusted would not hear the signal while receivers adjusted to hear transmitting stations assigned frequencies corresponding to the two coupling frequencies would hear the transmitter so strong as to be greatly interfered with in the matter of receiving their own communications. This, of course, is not localizing communication and making it possible to receive signals to the exclusion of other communications.

Neither does this arrangement involving tight coupling provide for efficiency from any point of view that efficiency can be considered. The figure shows that the energy of the waves radiated into space is distributed

among three different frequencies, and under such distribution there can be no efficient use of the energy.

I have quoted the statement of objects of the Marconi invention from the specification of the patent in suit as being obtaining efficiency and localizing communication. From my discussion above as to the effects of tight coupling it is quite apparent that the Marconi system did not include tight coupling—that tight coupling actually prevents obtaining the stated object.

[fol. 732] I have pointed out that the Marconi reference to efficiency did not make clear the specific form of efficiency sought, but after a consideration of the effects of coupling as I have discussed them, it begins to become clear that Marconi had in mind a particular kind of efficiency obtainable through concentrating the energy in the transmitting waves into one frequency.

I have mathematically shown that with a 20 per cent coupling between the two circuits the desired frequency of 1,000 kilocycles is not obtained, but that two coupling frequencies, one having the frequency of 1,112 kilocycles and another having a frequency of 913 kilocycles, are obtained. It may be well to consider here the practical effect of such communication upon radio practice. I have shown how different frequencies are assigned for different uses, and let it be supposed that the 1,000 kilocycle frequency is assigned for communication between ships and shore, 900 cycles for communication between seaplanes and coastal stations, and 1,100 cycles for communication between ships and radiocompass stations on shore. Under such circumstances it is apparent that if the ship to shore station instead of transmitting a frequency of 1,000 kilocycles as assigned, actually produces two coupling frequencies, one of 913 kilocycles and the other of 1,112 kilocycles, instead of successfully carrying on its own communications, it will amount merely to a double interfering agency annoying both the seaplanes and the radiocompass stations.

I will next endeavor to make clear the particular manner in which it is evident to me Marconi proposed to obtain efficiency and localizing of communication, employing a number of figures embodied in a sketch which I have made, marked "Loftin Sketch H." I have given the figures in this sketch, numbers corresponding to the figure numbers in my sketch F for the circuits, making it possible for

Marconi to secure the desired result, and these are the loosely coupled circuits of Figures 4 and 5 of my sketch F.

Figure 4 of my sketch H represents the long-drawn-out train of oscillations in the lateral circuit of Figure 4 of sketch F, which it is possible to obtain when the coupling with the elevated conductor circuit or antenna is loose, and when the spark gap is designed as I have previously described to permit of conserving the energy and drawing it out for a long time. I have shown these oscillations in purple because the coupling is so loose as to have the two coupling waves so close together in frequency as to result for all practical purposes in but a single frequency. The oscillations are shown as commencing quite strong with a large supply of energy available in the condenser *c* and gradually reducing in strength as the energy is transferred to the elevated conductor circuit or is wasted through unavoidable losses. The figure shows that the train of oscillations is uninterrupted by periods of no energy in the lateral circuit as was the case with tight coupling, the energy never being entirely transferred to the lateral circuit.

Figure 4a shows the oscillations in the antenna circuit resulting from the energy derived from the oscillations in the lateral circuit. I have assumed for the purpose of discussion and illustration that the capacity and self-inductance of the antenna have such values as to give them a product different from the product of the inductance and capacity of the lateral circuit, and I have assumed that the [fol. 733] product in the antenna circuit is less than the product of the lateral circuit—that is, that the natural frequency of electrical vibration of the antenna circuit is greater than the natural frequency of the lateral circuit.

Under such conditions, the oscillations of the lateral circuit will transfer energy to the elevated conductor circuit so that the energy will oscillate at the same frequency that it is received in part only, for some of the energy will take up another frequency, that of the natural frequency of the antenna circuit. The oscillations having the same frequency as that of the lateral circuit are termed “forced oscillations.” This means that there are no conditions in the antenna circuit supporting oscillations at this frequency, but since the energy is fed into the elevated conductor circuit a little at a time at a definite frequency, some of the energy is forced to maintain or act at the frequency from

which it is derived. I have illustrated this energy in purple, because it is of the desired frequency or pace set by the lateral circuit, which is adjusted to give the desired frequency. Examination of Figure 4a shows that the energy of the desired frequency in the antenna circuit is first small, but gradually builds up in strength as more energy is received from the lateral circuit, the rate of transfer being such that the energy received more than makes up for the energy radiated or unavoidably wasted. The figure shows after reaching a maximum the strength of the oscillations begin a decrease; this meaning that the lateral circuit can no longer supply energy in excess of that radiated and lost.

I have also shown in Figure 4a a train of oscillations in red, this representing that part of the energy in the antenna circuit takes up oscillating at the natural frequency of the circuit. These oscillations are shown to be less in strength than the desired oscillations in purple. The relation between the strength of the two oscillations will depend largely upon the resistance of the antenna circuit. At the point *x* opposite the point of Figure 4 illustrating the oscillations in the lateral circuit where the oscillations cease I have shown that the red and purple oscillations combine and continue on as red oscillations; that is, at the frequency of the antenna circuit. This means that the spark gap in the lateral circuit having become inactive and the lateral circuit no longer supplies the energy to the antenna circuit to force the oscillations to be largely maintained at the frequency of the lateral circuit, the energy then is left free to take up the natural period of vibration of the antenna circuit.

In Figure 4b of sketch H I have plotted the results of an arrangement of the kind of Figure 4 of sketch F, where I have assumed that the antenna circuit has a product of capacity and inductance different from that of the lateral circuit, giving oscillations of the kind illustrated in Figures 4 and 4a of sketch H. In Figure 4b the vertical dimensions represent signal strength and horizontal dimensions represent frequency. This figure shows that the oscillations in the antenna circuit of Figure 4a give a fairly strong signal of the desired frequency, the curve representing this being in purple. The small curve to the right in red shows that [fol. 734] the energy in the antenna circuit which takes up the natural frequency of the antenna circuit gives a signal of less intensity than that of the desired frequency.

This Figure 4*b* shows that with loose coupling the object of Marconi of localizing communication and of obtaining efficiency is better realized than under the conditions of tight coupling, most of the energy being concentrated in a frequency which is the desired one. It shows, however, that with the two circuits not carefully adjusted to have their products of capacity and self-inductance the same, there will result a second frequency which will require useless expenditure of some energy. In the discussion of the Lodge patent in suit it was pointed out that Lodge laid great stress on obtaining two conditions for a good resonant transfer of energy between two circuits; (1) obtaining a train of oscillations of long duration; (2) tuning the two circuits together; that is, making their products of self-induction and capacity the same. It is not to be expected that Marconi, after the teachings of Lodge, was satisfied with merely getting a long-drawn-out train of waves. We find in the Marconi specification that having prescribed persistent oscillation or maintenance of oscillation for a long time, he then sets forth the second step of Lodge, that of tuning, and thus avoided obtaining a second frequency as illustrated in Figures 4*a* and 4*b* of sketch H.

In the next group of figures of sketch H, Figures 5, 5*a*, and 5*b*, I show the results obtained by using both the loose coupling and making the products of self-inductance and capacity the same, as described by Marconi. Figure 5 shows the oscillations in the lateral circuit the same in character as Figure 4, the circuits being loosely coupled, permitting the lateral circuit oscillations to be substantially of one frequency character, this being illustrated by making the oscillations in purple. Figure 5*a* illustrates the oscillations in the antenna or elevated conductor circuit, and since the elevated conductor circuit has the same natural period or frequency as the oscillations in the lateral circuit, there is no tendency for another group of oscillations to build up, as in Figure 4*a*. The forced oscillations and the natural frequency oscillations are the same and they therefore join to give a one frequency oscillation of greater strength than either one of the oscillations in Figure 4*a*. This I have roughly illustrated by making the extent of the oscillations above the horizontal line in Figure 5*a* greater than in Figure 4*a*.

In Figure 5*b* the result of the one-frequency waves radiated from the antenna or elevated conductor circuit is

shown. As before, signal strength is represented by vertical dimensions and frequency by horizontal dimensions. The one curve in purple shows that signals of but one frequency are radiated. Since all of the energy of radiation is concentrated in this one frequency, it is quite natural that the signals on this one frequency should be stronger than when the energy is divided among several frequencies. I have roughly indicated this by making the curve in Figure 5b somewhat higher than the curves in Figure 2b and in Figure 4b.

Here, then, is the system of Marconi obtaining his two objects; first, localizing signals by concentrating the energy in one long-drawn-out train of oscillations of but one and the desired frequency, and, second, efficiency by concentrating all of the radiated energy into oscillations of but a single frequency.

[fol. 735] The desired result is obtained, first, by creating oscillations in a lateral circuit; second, by making the lateral circuit a good conserver of energy—not unreasonably wasteful; third, causing the oscillations in the lateral circuit to persist or be maintained for a long time—that is, having provided for conserving its energy not to cease slowly feeding energy to the antenna circuit unnecessarily early; fourth, slowly feeding energy into the antenna through a coupling sufficiently loose as not to disturb the frequency of the oscillations in the lateral pace-setting circuit to any practical extent; and, fifth, to adjust the antenna or good radiating circuit to have a natural period the same as the frequency period of the oscillations in the lateral circuit—that is, to get the resonant transfer of energy described by Lodge.

I find that the effect of closely coupled oscillating circuits on each other is well discussed by Zenneck in the 1915 edition of the book I have previously referred to from pages 87 to 93, inclusive. On page 89, Figure 124, Zenneck shows actual oscillograms of the current in coupled circuits corresponding to Figures 2 and 2a of my sketch G. The figure does not make clear that there are two oscillations of different frequency corresponding to the red and green oscillations of my figure. The oscillations are so rapid that there is no known instrument which would differentiate between the two for photographic purposes. The Zenneck figure does show very clearly that the energy is alternately transferred from one circuit to the other, being a maximum in one

circuit when practically nil in the other circuit. Examination of the figure shows that the lobes of maximum energy in one circuit are opposite the blanks or no energy spaces in the other circuit. Figure 125 on page 89 of the Zenneck book shows the same information obtained by photographing the sparks passing through spark gaps in the circuit. This figure clearly shows that energy is transferred from one circuit to the other, the gaps of no energy in one circuit being opposite those of maximum energy in the other circuit.

On page 94 of the Zenneck book, Figure 130, there is illustrated diagrammatically the alternate transfer of the energy between the two circuits similar to my Figures 2 and 2a of sketch G. Zenneck has made no effort to show that there are two frequencies in each of the circuits corresponding to my red and green, the purpose of the figure being merely to show that the energy is first all in one circuit and then in the other circuit, as represented by the high and low points in the two figures of the diagram marked "Primary circuit" and "Secondary circuit."

Pages 84 to 87 of the Zenneck book consider the matter of loose coupling between two oscillatory circuits. At the middle of page 85 Zenneck states:

"In our conception of very loose coupling, the oscillations in the primary circuit remain practically unaffected by the coupling with the secondary circuit. In the secondary there are produced in general, two distinct oscillations:

"1. One having the same frequency and damping as the oscillation of the primary—the so-called "forced" or "impressed oscillation."

"2. The other having the characteristic frequency and damping of the secondary circuit—the "free" or "natural oscillation."

[fol. 736] This quotation is a statement of what I have illustrated in Figures 4, 4a, and 4b of my sketch H. Zenneck states that under conditions of very loose coupling the oscillations in the primary circuit (the circuit which I have termed "lateral") are practically unaffected by the coupling with the secondary or elevated conductor circuit. I have illustrated this by making the oscillations in purple to represent one frequency. Zenneck then says that there are two distinct oscillations in the secondary or elevated

conductor circuit, one having the same frequency as the oscillations in the lateral circuit and one having the characteristic frequency of the elevated conductor circuit, which I have illustrated in Figure 4a by the purple and red oscillations.

At the bottom of page 85 Zenneck further states:

"b. The amplitudes of both the forced and natural oscillations become a maximum when the natural frequency of both primary and secondary circuits is the same, i. e., when the two circuits are "tuned" or "in resonance". Then the forced and natural oscillations have the same frequency and may be considered as constituting a single oscillation."

This last quotation is in language exactly what I have illustrated in my Figures 5, 5a, and 5b of sketch H. Figure 5a shows that when the secondary circuit has its natural frequency the same as that of the oscillations of the primary circuit; that is, has its product of inductance and capacity so adjusted as to be the same as the primary circuit, the forced and natural oscillations then combine to form a single frequency of oscillations of maximum intensity.

Having considered the Marconi invention from the point of view of the statement thereof in the specification, I will next proceed with particular reference to the subject matter set forth in the claims enumerated in the question. I find that claims 1, 3, 6, 8, 11, and 12 relate to the transmitting station. That claims 2, 13, 14, 16, 17, 18, and 19 to the receiving station, and claims 10 and 20 relate to both stations. I will take up these claims in the three groups, claim by claim, in each group, commencing first with the transmitting station claims. Claim 1 reads as follows:

"1. At a station employed in a wireless-telegraph system, a signaling instrument comprising an induction-coil, the secondary circuit of which includes a condenser discharging through a means which automatically causes oscillations of the desired frequency; an open circuit electrically connected with the oscillation-producer aforesaid and a variable inductance included in the open circuit, substantially as and for the purpose described."

This claim specifies the combination of a number of the elements found in Figure 1 of the patent and requires par-

ticular discussion as to one feature, being that part of the claim which reads "discharging through a means which automatically causes oscillations of the desired frequency." This, of course, to an engineer does not mean the spark producer, or spark gap taken by itself, for by itself it is not capable of producing oscillations of any nature. This expression necessarily includes the circuit connected with the spark gap, and requires that the circuit not only be capable of oscillating but must be capable of producing the oscillations at the frequency desired as the signaling frequency for the system in which the transmitter is used. I have shown that a circuit associated with another circuit such as the elevated conductor or antenna of Figure 1 is not capable [fol. 737] of producing oscillations of the desired frequency unless loosely coupled to the second circuit. It is therefore clear that the "means" referred to in claim 1 requires that the lateral circuit and the elevated conductor or open circuit shall be loosely coupled. The claim also provides for a variable inductance in the open circuit. This is for the purpose of adjusting the natural time period of the open circuit to the frequency of the oscillations in the primary circuit.

"Claim 3. At a station employed in a wireless-telegraph system, a signaling instrument comprising an induction-coil, the secondary circuit of which includes a condenser discharging through a means which automatically causes oscillations of the desired frequency, and the primary circuit of which includes a generator; means for varying the primary circuit; an open circuit electrically connected, and a variable inductance included in the open circuit, substantially as and for the purpose described."

This claim also specifies the combination of a number of the elements shown in Figure 1, together with "a means which automatically causes oscillations of the desired frequency," and is therefore clear that this "means," like claim 1, requires loose coupling between the circuits. It differs from claim 1 in the detail of claiming "means for varying the primary circuit." This addition is merely for any well known means to make it possible to vary the frequency of the "desired frequency" in order that the transmitting station should not be limited to a one frequency device. It simply provides for making possible through a well known means for transmitting at different frequencies from time to time as operating circumstances would require.

"Claim 6. At a transmitting station employed in a wireless-telegraph system, the combination of a transformer whose secondary is connected to an open circuit including a radiating-conductor at one end and capacity at the other end, and whose primary is connected to a condenser-circuit discharging through a means which automatically causes oscillations of the desired frequency, and means for adjusting the oscillation period of each of the two circuits connected with the transformer to bring them into accord with each other, substantially as described."

This claim, like claims 1 and 3, includes with the combination of a number of the elements of Figure 1, "a means which automatically causes oscillations of the desired frequency," which therefore makes it clear that this claim includes in the "means" loose coupling between the lateral and elevated conductor circuits. It broadly includes "means for adjusting the oscillation period of each of the two circuits," being any of the then well-known means for varying either capacity or inductance, specifically shown in Figure 1 as a variable condenser *c* in the lateral circuit and a variable inductance *g* in the elevated conductor circuit. In this way Marconi provided for a resonant transfer of energy between the two loosely coupled circuits.

"Claim 8. At a transmitting station employed in a wireless-telegraph system, the combination of a transformer whose secondary is connected to an open circuit including a radiating-conductor at one end and capacity at the other end, a variable inductance being included in said circuit, and whose primary is connected to a condenser-circuit dis- [fol. 738] charging through a means which automatically causes oscillations of the desired frequency, substantially as described."

This claim like the foregoing claims specifies the combination of a number of the elements of Figure 1 together with "a means which automatically causes oscillations of the desired frequency," and like the foregoing claims clearly includes in the "means" loose coupling.

"Claim 11. An apparatus for communicating electrical signals, the combination, with an oscillation-transformer, at a transmitting-station, of an induction-coil; an electric circuit containing the secondary of said coil, a condenser and the primary coil of the oscillation-transformer; a pro-

ducer of electric waves of high frequency electrically connected with the secondary of the induction-coil; a signaling instrument in circuit with the primary of the induction-coil; the secondary coil of the oscillation-transformer electrically connected, at one end to capacity and, at the other end, to an inductance, and an aerial conductor connected to the inductance, substantially as and for the purpose described."

This claim requires practically the same combination of the elements of Figure 1 as the foregoing claims, but changes the former language "a means which automatically causes oscillations of the desired frequency" to "a producer of electric waves of high-frequency electrically connected with the secondary of the inductance coil." Clearly this expression loosely employs the term "electric waves" for "electric oscillations." The expression requires that the producer be connected with the secondary of the induction coil, and therefore clearly means the primary or lateral circuit. Marconi has carefully explained in his specification that the lateral closed circuit is a poor radiator, and therefore does not effectively produce "electric waves," this being the function ascribed to the elevated conductor or open circuit. The expression "electric wave" generally means the form the energy takes after leaving the radiator and is traveling in space. "Electric oscillations" generally refers to the form of the energy while flowing as alternating current in a circuit. Undoubtedly the expression refers to the electric oscillations of high frequency in the lateral circuit, and undoubtedly has the same meaning as the expression used in the foregoing claims; that is, I understand the expression to mean that the lateral circuit is the producer of the electric oscillations of high frequency for the purpose of exciting the elevated conductor or antenna circuit with oscillations of the desired frequency for communicating electric waves.

Claim 11 makes no reference to adjustment of capacity and inductance of the two circuits. It is a broad claim on the association of two circuits at a transmitting station through an oscillation transformer where a number of specific elements are included in each of the circuits.

"*Claim 12.*—In apparatus for communicating electrical signals, the combination, with an oscillation-transformer,

at a transmitting station, of an induction-coil; an electric circuit containing the secondary of the said coil, a condenser and the primary coil of the oscillation transformer; a producer of electric waves of high frequency connected with the secondary of the induction coil; a signaling instrument in circuit with the primary of the induction coil; the secondary coil of the oscillation-transformer electrically connected, at one end to capacity and, at the other end, to a variable inductance, and an aerial conductor connected to the variable inductance, substantially as and for the purpose described."

The only difference between claim 12 and claim 11 is that the former specifies that the inductance in the elevated conductor circuit is "variable." The claim is subject to the same comment as claim 11.

Summarizing the group of transmitting claims above listed, it is to be noted that in no one of the claims does Marconi claim the two circuits actually in resonance. The claims include "means" for adjusting the time periods of the circuit, in some cases naming the specific devices; that is, Marconi only included in his claims the instrumentality for accomplishing the result. Adjusting the time period of circuits was old at the time of the Marconi application, and these claims clearly show that Marconi fully appreciated this and made no claim to two circuits having time periods in accord with each other. He merely included in his claims an enumeration of instrumentalities adapted to conveniently adjust the circuits to secure this relation.

"Receiving Claims

"*Claim 2.*—At a station employed in a wireless-telegraph system, an oscillation-receiving conductor, a variable inductance connected with said conductor; a wave-responsive device electrically connected with said conductor and in circuit with a condenser, substantially as and for the purpose described."

This claim sets forth the combination of a number of the elements of Figure 2 of the patent and in no way makes any suggestion towards the adjustment of time periods of the two circuits at the receiving station or considers the matter of resonance. It amounts to a mere combination of physical elements.

“Claim 13.—At a receiving-station employed in a wireless-telegraph system, the combination of an oscillation-transformer, an open circuit connected with one coil of said transformer, said circuit including an oscillation-receiving conductor at one end and capacity at the other end, a variable inductance being included in said circuit, a wave-responsive device electrically connected with the other winding of the oscillation-transformer, and a condenser in circuit with the wave-responsive device, substantially as described.”

Claim 13, like claim 2, merely sets up a combination of a number of elements in Figure 2 of the patent. It adds to the combination of claim 2 the oscillation transformer. Like claim 2, there is no suggestion of adjustment of the time period of the two circuits or reference to the matter of resonance.

“Claim 14.—At a receiving-station employed in a wireless-telegraph system, the combination of an oscillation-transformer, an open circuit connected with one coil of said transformer, said circuit including an oscillation-receiving conductor at one end and capacity at the other end, a wave-responsive device electrically connected with the other winding of the oscillation-transformer, and means [fol. 740] for adjusting the two transformer-circuits in electrical resonance with each other, substantially as described.”

Claim 14 includes with a combination of the elements of figure 2 of the patent “means for adjusting the two transformer circuits in electrical resonance with each other.” It does not claim two circuits “being in resonance,” but merely includes a generic way of stating some adjustable means in either one of the circuits, or in both, for adjusting to resonance, if desired. It clearly shows that Marconi appreciated that the art prior to him provided for resonance between two circuits at a receiving station, and made no claim to this condition. The claim here is for the “means” or instrumentality for adjustment in combination with other elements.

“Claim 16.—At a receiving-station employed in a wireless-telegraph system, the combination of an oscillation-transformer, an open circuit connected with one coil of said transformer, said circuit including an oscillation-

receiving conductor at one end and capacity at the other end, an adjustable condenser in a shunt connected with the open circuit and around said transformer-coil, a wave-responsive device electrically connected with the other coil of the oscillation-transformer, and means for adjusting the two transformer-circuits in electrical resonance with each other, substantially as described."

This claim is substantially the same as claim 14, being a combination of a number of the elements shown in Figure 2 with "means for adjusting the two transformer-circuits in electrical resonance with each other." There is no requirement that the two circuits shall be in resonance, but merely states generally a "means" or instrumentality for obtaining an adjustment for resonance, if desired, in combination with other elements. The claim differs from claim 14 particularly in including "an adjustable condenser in a shunt connected with the open circuit and around said transformer-coil." This is merely one of numerous ways for obtaining an adjustment of the product of capacity and inductance of a circuit, in this case the adjustment being obtainable through varying the capacity.

"Claim 17.—At a receiving-station employed in a wireless-telegraph system, the combination of an oscillation-transformer, an open circuit connected with one coil of said transformer, said circuit including an oscillation-receiving conductor at one end and capacity at the other end, a wave-response device electrically connected with the other winding of the oscillation-transformer, and means included in each of said transformer-circuits, for adjusting said circuits in electrical resonance with each other, substantially as described."

This claim, like claims 14 and 16, is for a combination of the elements shown in Figure 2 with "means included in each of said transformer-circuits, for adjusting said circuits in electrical resonance with each other." Like claims 14 and 16, it does not require that the two circuits be in resonance, but merely claims "means" or instrumentalities for accomplishing the result, if desired, in combination with other elements. Its specifically requires that there be means in both circuits.

"Claim 18.—At a receiving-station employed in a wireless-telegraph system, the combination of an oscillation-

transformer, an open circuit connected with one coil of said transformer, said circuit including an oscillation-receiving conductor at one end, and capacity at the other end, a variable inductance being included in said open circuit, a wave-responsive device electrically connected with the other winding of the oscillation-transformer, and a variable inductance included in circuit with the wave-responsive device, substantially as described."

This claim is merely for a combination of a number of the elements of Figure 2 of the patent and makes no reference whatever to adjustment of the time period of the two circuits or resonance. It merely requires a variable inductance in each of the two circuits in combination with other elements.

"*Claim 19.*—In a system of wireless telegraphy, the combination of a receiving-station, of an oscillation-transformer; an open circuit comprising, in part, an aerial conductor connected with one end of the primary coil of the oscillation-transformer; a connection from the other end of said coil to capacity; a variable inductance in said open circuit; and electrical connections from the secondary coil of the oscillation-transformer to a receiving instrument, battery, condenser, wave-responsive device and a variable inductance, substantially as and for the purpose described."

This claim, like claim 18, is merely for a combination of a number of the elements of Figure 2 of the patent, simply having a few more elements in claim 18. It makes no reference to or suggestion of adjustment of time periods of the two circuits or adjusting the two circuits to resonance.

Summarizing this group of receiver claims, I do not find any requirement by Marconi that the two circuits at the receiving station shall be adjusted to accord in time periods or adjusted to resonance. This clearly shows that Marconi fully appreciated that the art prior to him had disclosed this feature and Marconi made no claim thereto. His claims are for the means or instrumentalities for adjustment in combination with other specific elements.

"Claims Covering Both Stations

"*Claim 10.*—A system of wireless telegraphy, in which the transmitting-station and the receiving station each contains an oscillation transformer, one circuit of which is an open circuit and the other a closed circuit, the two circuits

at each station being in electrical resonance with each other and in electrical resonance with the circuits at the other station, substantially as described."

In this claim Marconi for the first time broadly claims electrical resonance between circuits, the claim requiring that all of the circuits of the system from beginning to end be in resonance. This clearly shows that while Marconi admitted that the prior art included tuning or resonance between the two circuits at a transmitting station and at a receiving station, he considered that he was the first to specify this condition for all four circuits making up two stations and was entitled to broadly claim it in a combination claim.

"Claim 20.—In a system of wireless telegraphy, a transmitting-station containing an oscillation-transformer, the primary of which is connected to a condenser-circuit discharging through a spark-gap which automatically causes electric waves of the desired frequency, the secondary of said transformer connected to an open circuit including a radiating-conductor, and with a capacity and a coil for [fol. 742] charging the condenser aforesaid; a receiving-station containing an oscillation-transformer, the primary of which is connected with an oscillation-receiving conductor and with a capacity, a wave-responsive device connected with the secondary of said transformer, and a receiving instrument connected with the wave-responsive device, all in combination with means for bringing the four transformer-circuits, two at each station, into electrical resonance with each other, substantially as described."

This claim is for a combination of the elements shown in both Figures 1 and 2 of the patent together with "means for bringing the four transformer-circuits, two at each station, into electrical, resonance with each other." Like the receiver and transmitter claims, this claim does not require electrical resonance throughout the four circuits, being merely for the "means" or instrumentalities for producing the result, if desired, in combination with other elements.

Summarizing the three groups of claims, it is clear to me that in the transmitter and receiver claims taken by themselves Marconi laid no claim to originality in adjusting the time period of the two circuits at each of the stations to accord or to obtain resonance. In these claims he very clearly shows that he merely considered that he was entitled to

claim the instrumentalities for accomplishing the result in combination with other elements. That when he came to the complete system involving four circuits he had a different view. He clearly considered that in the complete system he was entitled to broadly claim the condition of resonance throughout the system as a whole in spite of the prior art having disclosed transmitting stations having two circuits in accord and receiving stations having two circuits in accord.

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22. Question. Claimant's witness, Waterman, in his discussion under the title "The characteristics and properties of the oscillatory circuits," commencing at page 145 of his deposition, states as he understands the Marconi specification, it does not say or imply that when the two circuits are associated as shown, the oscillations in the primary or closed circuit persist for a long time or for any particular time. Do you agree with this understanding?

Answer. I do not agree with the understanding of Mr. Waterman that the Marconi specification does not say or imply that when the two circuits are associated as shown, the oscillations in the primary or closed circuit persist for a long time.

At page 145 of the Waterman deposition he quotes from page 2, lines 6 to 24 of the specification, as follows:

"The illustrated arrangement of parts at a transmitting station enables much more energy to be imparted to the radiator *f*, the approximately closed circuit of the primary being a good conserver and the open circuit of the secondary being a good radiator of wave energy. My experiments have demonstrated that the best results are obtained at the transmitting station when I use a persistent oscillator—an electrical circuit of such a character that if electromotive [fol. 743] force is suddenly applied to it and the current then cut off electrical oscillations are set up in the circuit which persist or are maintained for a long time—in the primary circuit, and use a good radiator—i. e., an electrical circuit which very quickly imparts the energy of electrical oscillations to the surrounding ether in the form of waves—in the secondary circuit."

The first point brought out by this quotation is that the arrangement of two circuits allows much more energy to

be imparted to the radiator f , the elevated conductor circuit.

Mr. Waterman in his deposition points out that the ordinary structure of an antenna or elevated conductor circuit prevents obtaining a large capacity, a capacity not nearly so large as is obtainable in a closed lateral circuit where the capacity can be determined by the choice of a condenser rather than upon the structure of the system. Mr. Waterman states that the capacity determines the amount of energy which a circuit can take without reaching excessive voltages or pressures. At the top of page 149 of his deposition, he sums up this matter as follows:

"Hence the amount of energy, and consequently the distance that could be reached with a given wave length by the original Marconi arrangement having the spark gap in the antenna, was limited by the small capacity of the antenna and the low charging pressure that could be applied to it on account of the presence of the spark gap."

The quotation from the specification states that a large amount of energy can be transferred from the lateral circuit to the elevated conductor circuit, but since Mr. Waterman points out that the capacity of the elevated conductor circuit for taking energy is limited, there necessarily results the conclusion that the large amount of energy transferred is not due to a quick or sudden transfer, but results from transferring little energy at a time over a long period of time.

The second requirement of the quoted paragraph of the specification is "the approximately closed circuit of the primary being a good conserver." This requirement has no meaning unless the energy remains long enough in the primary or lateral circuit for conservation. It would make no particular difference if the primary circuit were unreasonably wasteful if the energy only remained for a short time to give the wasteful characteristics an opportunity to act.

The third requirement of the quotation is that the primary or lateral circuit be a "persistent oscillator." This, of course, is very definite language and can only be construed to mean sustaining oscillations that persist or endure for a long time.

The fourth statement is "electrical oscillations are set up in the circuit which persist or are maintained for a long

time—in the primary circuit.” I do not see that there can be any doubt as to the meaning of language of this kind, especially when considered in connection with Marconi’s stated object of localizing communication. In discussing both the Lodge patent in suit and this Marconi patent in suit, Mr. Waterman and I have pointed out that better localizing, which is better selectivity, is obtainable through a long drawn out train of oscillations rather than through one which quickly dies out.

At page 146 of his deposition Mr. Waterman has quoted, from page 2 of the Marconi specifications, as follows:

[fol. 744] “If the capacity, the inductance and the resistance of the circuit are of suitable values, the discharge is oscillatory, with the result that alternating currents of high frequency pass through the primary of the transformer and induct similar oscillations in the secondary, these oscillations being rapidly radiated in the form of electric waves by the elevated conductor.”

The duration of oscillations in a circuit depends upon the relation of the capacity, inductance, and resistance of the circuit, this being expressed mathematically by the well-known formula

$$d = \pi R \sqrt{\frac{C}{L}}$$

in which d is the decrement or measure of the duration of the oscillation, R is the resistance of the circuit, C the capacity of the circuit, and L the inductance of the circuit.

The quotation requires proper adjustment of these values so that there will be high frequency oscillations to induct “similar oscillations” in the secondary. In my sketch G, Figure 2 and Figure 2a, I have shown that if the transfer of energy is too quick there will be two frequencies of oscillation not of the desired frequency and therefore there can be no “similar oscillations” of the desired frequency transferred to the secondary circuit.

At the middle of page 147 of his deposition, Mr. Waterman states:

“Marconi says, in the last-quoted paragraph, that the oscillatory character of the circuit is determined by the inductance, capacity, and resistance and the relation is such that a large capacity and small inductance means a very few oscillations.”

I do not find that Mr. Marconi said anything about "a very few oscillations" as covered by the latter part of the quotation from Mr. Waterman. I have mathematically shown this relation in the formula immediately preceding.

In the same paragraph from which I have above quoted Mr. Waterman, he states that he has calculated the duration of the oscillations for tune 1 of the table on page 4 of the Marconi specification, and find that there will result only three complete oscillations. I have also calculated the duration of the oscillations, assuming the same conditions as Mr. Waterman; that is, that the wave length is 200 meters, stated by Mr. Waterman to have been determined by him, which I assume to be through physical construction of the apparatus, and also assuming a resistance in the spark gap of 1 ohm. My calculation results in a decrement of 0.2 approximately, which gives 24 complete oscillations before falling to 1 per cent of the original value, and I have illustrated this in a sketch marked "Loftin Sketch J."

This decrement of 0.2 is the same as that prescribed by Congress in its act of August 13, 1912, which I have quoted at page 460 of my deposition. The paragraph of the act covering this matter of decrement is entitled "Use of a sharp wave." This means that the use of a decrement of 0.2 will give a wave sufficiently long drawn out or persistent to meet the requirement for selectivity set by Congress.

I have no objection to make to the assumption by Mr. Waterman of a wave length of 200 meters, as this is a matter which can be determined only by construction of the [fol. 745] apparatus following the dimensions given by the Marconi specification. I do object to Mr. Waterman's assumption of a resistance of 1 ohm for the spark gap resistance. This assumption I consider rather excessive, and I refer to the Zenneck book, translated by Selig, previously referred to, page 19, Figure 21, in which there are shown three curves of spark-gap resistance. Reference to these curves show that the spark gap resistances vary from one-tenth of an ohm to 1 ohm, making average conditions in the neighborhood of one-half ohm. If in calculating for the decrement I had used a value of one-half ohm, instead of the 1 ohm assumed by Mr. Waterman, the calculated decrement would be 0.1, instead of 0.2, resulting in a much more prolonged train of oscillations than that shown in my Sketch J. I consider the assumption of 0.5 ohms a much fairer as-

sumption than 1 ohm, and that a decrement of 0.1 more nearly approximates the decrement obtainable in tune 1 of the Marconi table on page 4 of the specification.

At the top of page 148 of the Waterman deposition Mr. Waterman points out that the conditions in the spark gap are also a factor in determining how long the oscillations will persist, a matter in which I have previously explained in great detail. Mr. Waterman summarizes these remarks as follows:

"And hence it quickly results that there is no longer a sufficient pressure in the circuit to cause the spark to jump the gap, and the oscillation of current in the circuit therefore ceases as soon as this condition is reached."

Just previous to making the above-quoted summary Mr. Waterman explained that as the current in the spark gap decreases the voltage required to start current for the next succeeding oscillation is increased, and his statement that there "quickly" results a cessation of oscillations would make it appear that he is setting forth this condition as a very critical one preventing obtaining persistent or maintained oscillations in the lateral circuit of Marconi when using a plain gap. I have explained that once the gap breaks down and becomes active the resistance becomes very low, so that the voltage can fall to a very small value and yet keep an active current flowing across the gap, with the result that the train of oscillations can be long drawn out before the voltage becomes too low to start the current flowing for the next oscillation. While it is true that the smaller the current across the gap, the greater the voltage required for the next succeeding oscillation, this is not a critical condition because the gap resistance becomes so low once the gap is active, that the voltage required to cause current to flow is very small. With the plain or open type of gap the voltage required to maintain oscillations with decreasing current can be made quite small with proper designed gap to prevent unreasonably early de-ionization of the gap, as I have previously explained in detail. I have pointed out that the roughly described gap of Marconi provided some of the essential elements for maintaining ionization of the gap for a long time, and thereby provide a train of persistent oscillations for slowly feeding energy to the elevated conductor circuit.

In the second paragraph of page 148 of the Waterman deposition Mr. Waterman states at the end of the paragraph as follows:

[fol. 746] "And upon how closely the two circuits are associated, and therefore how rapidly the energy is transferred from one circuit to the other."

This quotation implies that if the two circuits are closely associated there will be a rapid transfer of the energy from the primary or lateral circuit to the elevated conductor circuit, but does not explain that if the circuits are so closely associated as to have a rapid transfer of energy from the lateral circuit to the elevated conductor circuit, that such close association will result in a retransfer of energy from the elevated conductor circuit back to the lateral circuit, resulting in a long drawn out series of oscillations, impure and badly disturbed by this close association, as I have illustrated in Figures 2 and 2a of my sketch G.

I am, therefore, of the opinion that Marconi definitely provided for a long drawn out train of oscillations in his lateral circuit to slowly feed energy through loose coupling to an elevated conductor circuit so that the oscillations in the elevated conductor circuit would, through being undisturbed by tight coupling, have the same frequency as the oscillations in the lateral circuit, and would be long drawn out through obtaining a constant feeding of energy from the persistently oscillating lateral circuit.

23. Question. Mr. Waterman, under the title "Current oscillation and energy transfer," at page 151 of his deposition, introduces the sketch marked "Waterman's Sketch 2," illustrating the oscillation of current in the two circuits of a transmitter properly adjusted as described in the specification. Do you agree that the Waterman sketch 2 correctly illustrates the oscillation of current in the two circuits of a transmitter adjusted as described in the specification of the Marconi patent 763772 here in suit?

Answer. I do not consider that the Waterman sketch referred to properly illustrates the oscillations of current in the two circuits of a transmitter adjusted as described in the specification of the Marconi patent 763772 here in suit. The upper set of oscillations of the figure representing the "oscillations of primary circuit" only illustrates four complete oscillations which I consider to be far too few to repre-

sent the condition of persistently or maintained oscillations as required by the Marconi specification. In my sketch J I have illustrated the result of my calculations as to tune 1 on page 4 of the Marconi specification using Mr. Waterman's assumption as to the resistance of the spark gap, which I explained was unnecessarily high. My sketch J shows that even with a high resistance a train of oscillations much longer than that illustrated by Mr. Waterman in his sketch No. 2 is obtained. The oscillations would not be as long drawn out as shown in my sketch J when the primary circuit is feeding energy into the elevated conductor circuit, but as this feeding is slow, the duration of the train would be but slightly reduced, and would be like the arrangement I have shown in Figure 5 of my sketch H.

In the lower half of the sketch marked "Oscillations of secondary circuit," Mr. Waterman shows the oscillations to rapidly build up to an intensity practically the same as that illustrated as the initial intensity of the oscillations of the primary circuit.

Such a condition could only be obtained through the use of a very tight coupling, which would result in the condition [fol. 747] of affairs illustrated in Figures 2 and 2a of my sketch G, where the red and green curves show that there are two decided oscillations of widely different frequencies resulting from tight coupling. With tight coupling to get such a rapid transfer of energy into the secondary circuit as illustrated by Mr. Waterman, the oscillations in the primary circuit would not cease at the point *y* as illustrated by Mr. Waterman, but would commence to build up again on energy retransferred from the elevated conductor as illustrated in Figure 2 of my sketch G. This retransfer of energy from the secondary circuit would not permit the gradual fall of intensity of oscillation as shown in the lower half of the sketch, but would result in the oscillation immediately falling to a very low value as shown at the point *q'* in Figure 2a of my sketch G, and so on as the energy is shifted from one circuit to the other.

The real conditions in accordance with the Marconi specification in my opinion are illustrated in Figures 5 and 5a of my sketch H, in which it will be noted that the oscillations in the lateral circuit continue for a long time after the oscillations in the antenna circuit have reached the maximum; that the maximum values of the oscillations in the antenna circuit are small as compared to the value of the oscillations

at the beginning of oscillations in the lateral circuit, because the coupling is loose and the energy is transferred slowly.

In my sketch marked "Loftin Sketch K," I reproduce in Figure 1 approximately Mr. Waterman's sketch No. 2, and in Figure 2 I illustrate my conception of the oscillations in the two circuits when adjusted as described by the specifications, using approximately the same proportions as illustrated by Mr. Waterman for the oscillations of the primary circuit.

Referring to Figure 1 of my sketch K, the total area covered by the oscillation of the primary circuit as illustrated by Mr. Waterman represents the total energy in the primary circuit available for transfer to the secondary circuit. The total area covered by the oscillations illustrated by Mr. Waterman in the secondary circuit represents the total energy in that circuit. A casual inspection of the two groups of oscillation shows that Mr. Waterman illustrated energy in the secondary circuit two or three times as great as that available in the primary circuit, which of course is impossible. Only a fraction of the energy can be taken up by the secondary circuit as much is lost in the primary circuit, and this I have illustrated in Figure 2 of my sketch by showing the area of the total oscillations in the secondary circuit considerably less than the area of the total oscillations in the primary circuit.

Mr. Waterman also illustrates the intensity or height of oscillation in the secondary circuit the same as that in the primary circuit. This is a condition which could not even be obtained with 100 per cent coupling between the circuits. Both Mr. Waterman and I have stated that 100 per cent coupling between electrical circuits is an impossibility, and I have pointed out that in the use of high frequencies [fol. 748] where iron core transformers can not be used, that couplings are generally below 50 per cent.

The Waterman illustration is absolutely inconsistent with the Marconi specification. It shows a very short duration of the oscillations in the primary circuit, contrary to the Marconi insistent instructions to have persistent oscillations, maintained for a long time. With the oscillations cut off so early, it would be impossible for the primary circuit to act as a reservoir circuit, conserving energy as specified by Marconi, and slowly feeding it into the secondary circuit at the required frequency.

My illustration in Figure 2 shows a persistent train of oscillations in the primary slowly feeding energy into the secondary circuit. There is no quick transfer of energy with a quick cut-off in the primary circuit as illustrated by Mr. Waterman, nor would any such quick cut-off be possible, as a large amount of energy in the secondary circuit would force a return to the primary circuit causing the oscillations to again build up in the primary, and so on.

The illustration of Mr. Waterman is typical of that usually found in text books illustrative of the action of the "quenched gap" type of transmitter that became known to the radio world a decade after the Marconi invention.

Commencing at the bottom of page 151 of his deposition, Mr. Waterman states as to his sketch No. 2 as follows:

"In this manner, as a result of the resonant relation of the two circuits, energy is first taken in the primary circuit which can not radiate it, and is transferred from that circuit in the form of resonant oscillations set up in the secondary circuit. If the circuits are properly adjusted and also properly associated with one another, this transfer takes place as indicated in the sketch No. 2, the antenna circuit gradually taking over the energy from the primary circuit and then radiating it in this space."

This statement is absolutely unjustified by the conditions illustrated in Mr. Waterman's sketch No. 2. He has shown a transfer of energy so quick that a very tight coupling would be necessary to accomplish the transfer at the rate shown, and there would result two coupling frequencies very widely separated from each other and from the natural frequency of the two circuits. There is and can be no resonant relation between things which differ in frequency, and there are no resonant oscillations transferred to the secondary circuit. The condition would be that illustrated in Figures 2 and 2a of my sketch G, which is totally devoid of resonant relation or effects.

24. Question. Mr. Waterman under the heading "Degree of coupling or association of circuits:" at page 152, discusses the effect of looseness of coupling and applies this to his sketch No. 2. Does Mr. Waterman's Figure 2 correctly illustrate his remarks concerning loose coupling?

Answer. Under the heading quoted in the question, Mr. Waterman states that the coupling can not be too close if the results indicated in the sketch No. 2 are to be obtained, and he goes on to show how the Marconi specification pro-

vided for a sufficiently loose coupling. He does not, however, properly indicate a result that would be obtained with loose coupling, his transfer of energy being illustrated as so quick as to be obtainable only through tight coupling. [fol. 749] Mr. Waterman then goes on to explain very much in the same manner as I have already done the ill effects of tight coupling; he mentions the two coupling frequencies and the repeated transfer of energy from one circuit to the other, and the radiation from the antenna circuit of waves of two frequencies instead of the desired frequency. In spite of this, his Figure 2 represents a tight coupling quick transfer of energy, but fails to illustrate any of the ill effects that he says will accompany such transfer.

After enumerating the ill effects which result from tight coupling, Mr. Waterman states at the middle of page 153 of his deposition the following:

"It is important, therefore, in order that the efficient radiation to which the patent refers may be secured that the association between the two circuits should not be so close as to permit the secondary circuit to break down the spark gap by reaction upon it. When the association is a proper one the oscillation of the primary circuit will cease, as shown in Waterman sketch No. 2, as soon as the primary circuit has transferred its energy to the secondary and the more quickly this can be done the better, because the smaller will be the energy consumed in the primary circuit itself and the greater will be the amount remaining to be radiated."

This quotation very properly advises the use of loose coupling in accordance with the Marconi specification, and no order of loose coupling suitable for obtaining the condition set up in the Marconi specification will result in the type of oscillations illustrated in the Waterman sketch No. 2 referred to by Mr. Waterman in the quotation. Mr. Waterman states that when the association is a proper one the oscillations in the primary circuit will cease early as shown in this sketch, but Mr. Waterman neglects to say what this association is. As a matter of fact, the cessation of oscillations in the primary circuit is not determined by the association of the two circuits, but upon spark gap conditions opposed to those which are necessary to secure the long drawn out persistent oscillations in the primary circuit of

the Marconi invention. No open or plain gap of the Marconi type will give the early cut off of energy illustrated by Mr. Waterman in his sketch 2, and there is no foundation for the figure either in the Marconi specification, or in the way that the Marconi apparatus will function under any form of adjustment or association of circuits. The figure is practically the counterpart of that shown in most textbooks as typical of the action of the quenched gap type of radio transmitter which became known to the radio world about 10 years subsequent to the Marconi invention.

The quick transfer of energy and early cut off illustrated by Mr. Waterman takes away from the primary circuit all ability to create oscillations of the desired frequency. This creation of oscillations of the desired frequency in the primary circuit of the Marconi arrangement is of extreme importance. It is only through having the oscillations to so originate that the benefit of having all four circuits of the system in resonance is obtained. This feature is so important that it is one of the outstanding elements in the [fol. 750] transmitter claims of the patent, being covered in these claims as "a means which automatically causes oscillations of the desired frequency." As Mr. Waterman has illustrated the oscillations, the desired frequency is not created in the primary circuit, but in the secondary circuit, an idea entirely foreign to the Marconi specification and claims. During the short interval of time in which Mr. Waterman has illustrated oscillations as going on in the primary circuit, there are two widely separated frequencies, neither of them of the desired frequency. He, however, neglects to illustrate this fact.

Mr. Waterman makes the following observation as to the requirement in the Marconi specification that the product of inductance and capacity be adjusted to the same value near the bottom of page 153 of his deposition:

"It will be observed that the resonant relation between the two circuits, as set forth in the patent, is stated in somewhat mathematical terms—that is, as equality of the products of the capacity and the self-inductance in the two circuits. It must not be understood from this that effective operation requires a rigidly or mathematically exact adjustment of the two circuits, nor that the mathematical statement expresses the way of doing it, for neither of these things is true. No mathematically exact or precise equality

between the circuits is realizable in practice, but it is important to the efficient transfer of energy that this equality should be approximately or substantially attained."

I do not agree with Mr. Waterman that this adjustment is not a precise one. For the efficiency and localization of communication desired by Marconi this adjustment is extremely vital and should be made with all the precision that practical apparatus will permit. Referring to my sketch H, Figures 4 and 4a, I have shown that unless the two circuits are so adjusted there will result two oscillations, one of the desired frequency termed a "forced oscillation," and one of an undesired frequency which is the "natural oscillation" of the secondary circuit. In addition to the out of adjustment arrangement preventing the best transfer of energy, it also acts to divide the energy which is transferred into two components, one of which is not of the desired frequency and therefore deprives the desired frequency of a part of the total available energy. The apparatus illustrated by Marconi is capable of the desired precision of adjustment, he having shown both variable condensers and inductances, and in order to get the stated object of Marconi he must so adjust the circuits.

25. Question. Mr. Waterman in his answer to question 8, has given his understanding of the meaning of the expressions "tuning," "resonance," "syntony" and "selectivity." Will you state your understanding of these terms as employed in connection with the Marconi patent in suit?

Answer. Mr. Waterman points out that both Marconi in his reissue patent in suit and Lodge in his patent in suit, both refer to "syntony" or "tuning" between stations: that is, between transmitting and receiving stations. This means that they both had the idea of transmitting electrical waves of a definite frequency and by providing a receiver having its natural period adjusted to oscillate at this same frequency it would be better adapted for absorbing the [fol. 751] energy of the waves, just as I have explained in connection with stretched strings or other vibrating bodies. Mr. Waterman points out that the early Marconi patent was not capable of using syntony, tuning or resonance to obtain selectivity to any appreciable extent, because the Marconi radiator radiated its energy too quickly to permit of a resonant building up at the desired frequency to the exclusion of

other frequencies; that Lodge improved upon Marconi's early showing by prolonging the duration of the radiation of electric wave of the desired frequency so that a receiver having its frequency of natural oscillations adjusted to be the same as the radiated wave frequency, would resonantly absorb the energy from space; that is, it would syntonize with the radiated frequency or be in tune therewith. When good syntonny or tuning is had, the system is said to be "selective," being able to distinguish radiations of one frequency from radiations of another frequency through more readily absorbing one as compared to the other. This may be termed "resonance," because there is a resonant building up in the absorbing circuit of energy through gradually absorbing energy from the impressing source of the desired frequency.

Resonance, tuning, or syntonny, the terms being practically synonymous, is not obtained merely through the adjustment of the product of inductance and capacity, but requires an interlinkage relation of the circuits such that there will not result two frequencies, and also requires that the oscillations be sufficiently long drawn out to result in a resonant building up of energy. It is readily apparent that a transmitting station and a receiving station, being widely separated, have the desired degree of loose coupling to prevent the transmitting circuit and receiving circuit from interacting so as to cause two frequencies. This is a case of extremely loose coupling. When it comes to a case of a primary circuit feeding energy into a secondary or antenna circuit as in the Marconi patent at the transmitter, there can be no syntonny, tuning, or resonance between the two circuits unless the coupling is so chosen as to avoid the development of noticeable coupling frequencies. There must be but one frequency in order that the secondary circuit may adjust its capacity and inductance so as to give the secondary circuit a natural period of oscillation the same as that of the desired one frequency of oscillation in the primary circuit. The oscillations in the primary circuit must endure for a long time, as, with loose coupling to avoid two frequencies, energy is fed very slowly into the secondary circuit, and unless it can be fed over a long period of time no considerable quantity of energy will be acquired by the secondary circuit. Under such condition of a single frequency and a long drawn out feeding of energy, excellent resonance between the two circuits is ob-

tained by adjusting the product of capacity and inductance of the two circuits to be the same.

Marconi having provided for his initial circuit originating long drawn out oscillations of one frequency can very successfully use resonance throughout his entire system of four circuits.

At the middle of page 163 of his deposition, Mr. Waterman makes the following statement as to the Marconi four circuit tuning or resonance:

"Thus this idea of resonance between local circuits in the Marconi second or tuning patent is an entirely different thing from the interstation tuning referred to in the first [fol. 752] Marconi patent and the Lodge patent, but it is a means which, while increasing the energy and the distance of signaling, possible with antennae of give dimensions, also improves and facilitates interstation tuning."

Here he does not give the Marconi patent 763772 any credit for interstation tuning, this being attributed to the first Marconi patent and the Lodge patent, but does give Marconi credit for making it possible to transfer energy from a local circuit to a radiating circuit in such a way as to preserve the interstation tuning of these earlier patents, and says this is accomplished by the "idea of resonance between local circuits in the Marconi second or tuning patent," to which I agree, but this statement here by Mr. Waterman of the Marconi invention is not in keeping with the illustration in his sketch No. 2, in which there is no semblance of a resonant relation between the two circuits. The sketch shows a quick dumping of energy from the primary to the secondary circuit without in any way having the aid of resonance or using the idea which he in the above quotation attributes to the Marconi tuning patent.

26. Question. Please look at Waterman's sketch No. 3, opposite page 155 of the record, and say if you agree with Mr. Waterman that that sketch correctly illustrates the apparatus of Figure 2 of the Marconi patent 763772?

Answer. I note that Mr. Waterman has removed the condenser i^3 from the position it occupied in Figure 2 of the Marconi patent, namely, interposed between the two parts of the coil j^2 and placed it in parallel with the variable condenser k' and in series with the detector T. There is no justification in the Marconi figure or in the Marconi speci-

fication which I have been able to find for this change. In the position shown in the Marconi figure the condenser j^3 acts in series with the condenser h' and in series with the inductances of the coils j^2 and g^2 , and has its share in affecting the product of inductance and capacity of the circuit. In the position shown by Mr. Waterman in his sketch No. 3, the condenser j^3 is placed in series with the high resistance of the detector T, effectively removing it from the circuit in which it was originally placed by Marconi and depriving it of any function or effect upon the adjustment of that circuit, or upon the division of the electromotive force between the capacity elements of the circuit. When a circuit is resonant to the received frequency the counter electromotive force across all of the capacity of the circuit is a maximum and equal to the counter electromotive force across all of the inductance of the circuit, but the two are opposed. The counter electromotive force across either one of these characteristics is a maximum at resonance and this is why a detector connected across one of these elements so as to be influenced by the total counter electromotive force gives the maximum response at resonance. It is readily apparent that if the total capacity to obtain resonance is divided over several elements, such as the condensers j^2 and h' in Figure 2 of the Marconi patent, the detector if connected across only one of these will be influenced by only a part of the total available electromotive force. The effect on the detector in shunt with only one element will be in proportion to the relative values of the two elements, and in the arrangement of Marconi Figure 2 with his detector T across only the condenser h' , conditions of adjustment could arise where a very small effect on the detector T would be had and thus make it difficult to determine whether or not the circuit is in resonance. The Waterman sketch 3 removes this defect in the Marconi Figure 2 by taking the condenser j^3 out of the tunable circuit so that all of the electromotive force due to capacity will fall across the condenser h' giving the maximum effect upon the detector T not provided for by Marconi.

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27. Question. Will you refer to the prior art in connection with the claims in suit of the Marconi patent 763772 and state whether, in your opinion, one skilled in the art at the date of the application for the Marconi patent would have

possessed the requisite knowledge to make and use such devices without reference to the Marconi patent?

Answer. In my opinion the prior art clearly and precisely provided for the devices covered by the claims in suit of the Marconi patent 763772 at the time of the filing of the application for the patent.

The claims, which I have heretofore discussed and divided into three groups, nearly all cover means or instrumentalities for bringing circuits into resonance or for bringing them into time period accord, and one of the claims, No. 10, broadly requires that four circuits of the system be in resonance.

Before considering the claims individually, it may be well to first appreciate the relation of wireless telegraphy or radio, as it is now called, to the general electrical art, and particularly with wire telegraphy and wire telephony, and then to point out specifically some of the art in electricity applied to both forms of applications; that is, wire systems and wireless systems.

There has been considerable effort among workers in radio to create the impression that radio is a separate and distinct art from electricity in general, even including its applications to wire communication, and that radio involves numerous complicated and abstruse principles not encountered in the general application of electricity; and there has been a particular effort to differentiate radio from other applications of electricity on the grounds that radio because of employing high frequency electrical oscillations, is different from other applications of electricity. These efforts on the part of some of the workers in radio have succeeded in creating some rather false impressions as to what radio actually is. In my study of electricity, including radio and applying the principles, I have not encountered a single principle or formula that does not apply to electricity in general if it truly applies to radio, and in employing the formulae it is merely a matter of inserting the proper value of frequency to obtain the correct answer. Furthermore, it is not true that high-frequency oscillations originated with or are peculiar to radio. Before Mr. Marconi filed his first application for a patent in 1895 or 1896 several workers in the electrical art filed applications covering systems of wire telegraphy and telephony using high-frequency electrical oscillations conveyed along wires for transmitting proper signals. One of these applications was

that of Hutin and LeBlanc, filed May 9, 1894, and now being [fol. 754] United States Patent 838545 of December 18, 1906. The high-frequency system for wire communication has been as successful as the high-frequency system for wireless communication, both being in extensive commercial use to-day, and both employing practically identical apparatus at the transmitting and receiving stations, the only difference being that one employs wires for directing the energy to a particular receiving station and therefore is much more economical and requires less power at the receiving station than the other, which dumps its energy into space with the hope that some of it will reach the desired receiving station, but in order to make the hope more certain employs a large amount of power.

Resonance, including resonant transfer of energy and resonant absorbing of energy by proper adjustments of frequencies through adjustment of capacity and inductance of electrical circuits, was thoroughly appreciated before either the suggestion for high-frequency wire communication or high-frequency wireless communication was suggested, as I have more specifically pointed out in my discussion of the Lodge patent here in suit, showing that even Hertz, the very first investigator, employed resonance. It is therefore quite natural that the workers in both wire high-frequency telegraphy and telephony and wireless telegraphy should immediately adopt the principles of resonance for transfer of energy and absorption of energy. For instance, in United States Patent 519347, of May 8, 1894, to Pupin, resonance is a vital part of a system of wire telephony, as may be readily seen from a reading of claim 1 of the patent as follows:

"1. A transformer having one of the coils divided into sections, the said sections being connected in series and in electrostatic inductive relation and each section being tuned to a certain predetermined periodicity."

In another Pupin patent, 640516, filed May 28, 1895, and resulting in a patent January 2, 1900, the title is "Electrical transmission by resonance circuits." In the body of the specification, of the same patent, lines 68 to 74, page 1, there is the following "resonance" language:

"By a 'resonance-circuit' is meant one which has self-induction and capacity and therefore a natural period.

When the self-induction and capacity are properly adjusted so as to give it the period of the impressed electromotive force, the resonance-circuit becomes resonant to this electromotive force."

And lines 62 to 67, page 1:

"In multiple telegraphy by resonance-circuit it is necessary to employ selective circuits at the receiving end of the line. The employment of resonance shunt-circuits for selective receiving-circuits offers many important advantages."

Certainly, there could be no more definite appreciation of resonance and how to obtain it than that stated in the first quotation, and no more definite appreciation of its value than that stated in the second quotation. The matter of multiple telegraphy over wires employing a series of different frequencies with selective generators of these frequencies, and selective receivers for the generated frequencies, is identical with the matter of multiple telegraphy in radio employing a series of frequencies with selective generators of these frequencies, and selective absorbers at the receiving station.

[fol. 755] In the matter of the use of high-frequency electrical oscillations for wire communication, taking advantage of resonance and selectivity, and the proper construction of the circuits and devices for getting the best result, nothing could be more definite than the instructions and specifications laid down in United States Patent 638152 of November 28, 1899, to Stone, the application for which was filed December 15, 1896. For instance, lines 13 to 28, page 1, we find the following:

"When a telephone-receiver is subjected to a uniform vibratory current whose frequency of vibration corresponds to a tone of a pitch above the limit of audibility or corresponds to a tone of a pitch higher than the highest tone to which the moving parts of the receiver are capable of responding, the telephone remains silent. When, however, the intensity or amplitude of the high-frequency current to which the receiver is subjected is not uniform, but is subjected to slower periodic vibrations whose frequency corresponds to the pitch of an audible tone or combination of tones to which the moving parts of the receiver are capable

of responding, the receiver reproduces the tone or combination of tones."

In this quotation we have precisely the statement of the fundamental requirements for both radio telephony and wire telephony, sometimes termed "wired radio," both of which systems I have explained are in common use today using the same apparatus in both transmitting and receiving stations.

The manner of obtaining the high-frequency oscillations, or "carrier currents," as they are sometimes termed, because they carry the low-frequency variations characteristic of the voice or signal, is described, lines 29 to 35, page 1, as follows:

"In the present invention the high-frequency currents is developed by the disruptive discharge of a condenser in a sonorous circuit, and the required variations in the amplitude of the high-frequency current are obtained by varying the length of the spark tap at which the disruptive discharge takes place."

The manner of creating the high-frequency oscillations for delivery to the telephone line, as described in this paragraph, is precisely the same as the manner described by Marconi in the patent in suit, being merely "the disruptive discharge of a condenser in a sonorous circuit," "sonorous" in this case meaning the same as "persistent" in the Marconi description.

Page 2, lines 2 to 5, Stone provides for selective resonance between the transmitter and receiver, permitting the use of a plurality of noninterfering communications as follows:

"For this purpose, the sonorous resonanting-circuit at 1a and the resonator-circuit at 1b are attuned to the same frequency, while those at 2a and 2b are attuned to some other frequency."

It will be noted that Stone does not provide for tuning the line connecting the transmitting and receiving circuits, as in the system described he is transmitting a plurality of frequencies over the same line, and nothing would be accomplished by tuning the line to one of these frequencies and neglecting tuning of the line for the other frequency.

This is precisely the same arrangement adopted by Stone in a patent application filed prior to the Marconi application covering radio communication which I will discuss in detail later, where he desired to employ the same antenna or radiating circuit to transmit a plurality of signal carrying frequencies delivered to the circuit by a plurality of oscillation generators. The same application covers an arrangement for communicating with but one frequency or with a plurality of frequencies from the same antenna, and the Stone application provided for the antenna being tuned or not, depending upon whether he was using the multiple system or the single system.

Page 2, lines 39 to 47 inclusive, Stone describes the operation of the primary or oscillation-producing circuit, as follows:

"In this way a uniform oscillatory current of inaudible frequency is developed in the primary circuit, including the primary helix P, which oscillatory current is impressed upon the main circuit by means of the induction-coil I. The frequency of this oscillatory current is determined by the electromagnetic, electrostatic, and dissipative resistance of the primary circuit."

Technically, this is precisely the same language as that found in the Marconi specification. Stone states that the oscillatory current is of "inaudible frequency," meaning too high frequency to be directly detected by the human ear, which is the high frequency referred to by Marconi. Stone says the "oscillatory current is impressed upon the main circuit by means of the induction-coil I." This induction-coil I is the same as the oscillation transformer of Marconi to impress the oscillations on the antenna circuit. Stone then says that the oscillations have their frequency determined by the capacity, inductance, and resistance of the circuit, which is precisely the same statement made by Marconi. In other words, Stone, prior to Marconi, generated through the aid of the disruptive discharge of a condenser through a spark gap oscillations of one frequency determined by the product of capacity and inductance of the circuit, and impressed these one frequency oscillations upon a second circuit where they conveyed to a distance the desired electrical communications.

As to the manner of adjusting the circuits to accord or for resonance, Stone states, lines 107-120, page 2, as follows:

"The frequency of the current developed by the transmitting sonorous circuits is determined by the self-induction and capacity of the circuit including the primary of the induction-coil, the induction-coil, the condenser, and the spark-gap, and by properly proportioning this self-induction and capacity any desired frequency between very wide limits may be obtained. The attuning of the receiving-circuits is likewise accomplished by proportioning the inductance of the secondary circuit to the capacity of the condenser located in the secondary circuit."

No more definite instructions than these can be given for the bringing of the time periods of circuits into accord, and technically it is the precise language of the Marconi patent.

The last paragraph of the Stone specification, lines 121 to 130, inclusive, is extremely pertinent and valuable, and should have taught much to those workers in the art who were pleased to draw a great difference between high frequency and low frequency electrical effects:

"For the proper operation of sonorous circuits and of resonant circuits generally it is of the greatest importance that the inductance, and electrostatic capacity of the circuit be of the elastic type, and for this purpose dielectric and magnetic hysteresis, Foucault currents, and closed second-[fol. 757] ary reactions generally should be avoided or minimized by any means best adapted for the purpose."

In this quotation Stone broadcasts the warning that in dealing with high-frequency currents structures should be avoided which would permit of large dielectric and magnetic hysteresis, or Foucault currents. These hysteresis and Foucault current effects merely amount to losses produced by alternating current, and increase with the frequency of the alternations. Stone warned that since the frequency was high these losses would be large unless special provision was made to keep them low. In the construction of high-frequency apparatus in all of its uses, such as wired radio and wireless good design has followed the instructions of Stone, the quality of the apparatus depending upon how low the losses are. Even the amateur of to-day buying a condenser of the variable capacity type for building his radio receiving set knows enough to seek one that has low losses, for he has been told that such a condenser makes his receiver more selective.

The last part of the quotation has a particular bearing on the Marconi arrangement, for it directs the use of "loose coupling" to which I have freely referred. The statement is "closed secondary reactions generally should be avoided." This means that the association of the two circuits should be such as not to create the two coupling frequencies which will result from a tight coupling. Stone appreciated that such reaction could be created and would destroy the purpose of the system if permitted, and carefully warned against it.

In discussing the Marconi reissue patent in suit and the Lodge patent in suit, both prior to the application for the Marconi patent now in discussion, it was pointed out that Marconi and Lodge directed the use of resonance between the transmitting and receiving stations by adjusting the circuits to have the same time periods, or same products of self induction and capacity. This fact, taken together with the prior art I have just cited, which is an extremely small part of the art available, clearly establishes that the Marconi patent now under discussion was in no way responsible for the principles of resonance, and I find that my view in this respect is in accord with that of Mr. Waterman, plaintiff's expert, as clearly stated by him at pages 162 and 163 of his deposition. At the middle of page 163 Mr. Waterman summarizes the difference between the Marconi patent under discussion and the prior Marconi and Lodge patents as follows:

"Thus this idea of resonance between local circuits in the Marconi second or tuning patent is an entirely different thing from the inter-station tuning, referred to in the first Marconi patent and the Lodge patent, but it is a means which, while increasing the energy and the distance of signaling, possible with antennae of given dimensions, also improves and facilitates interstation tuning.

"In the first Marconi patent and in the Lodge patent there is one circuit at the transmitting station and one circuit at the receiving station tuned to agree with the transmitter. In the arrangement of the second Marconi patent there are two circuits tuned to resonance with one another at the transmitting station and two circuits tuned to one another at the receiving station, these circuits being also tuned to the wave length emitted by the transmitting station."

[fol. 758] There appears then to be no contention that Mr. Marconi put resonance in radio, but I understand Mr. Waterman's summary to mean that it is merely contended that Mr. Marconi added to existing resonance systems a couple of steps that would work better under resonant conditions. I also understand his summary to include a comparison between the later Marconi patent and the earlier Lodge and Marconi patents, and not other art. I understand the two steps pointed to with emphasis by Mr. Waterman to be the adding of a lateral circuit at the transmitting station tuned to the antenna circuit and the adding of a lateral circuit at the receiving station, tuned to the antenna circuit, but I do not find that Mr. Waterman points to any coupling condition between the circuits that will permit in practice of usefully employing resonance between the circuits, which I have pointed out is vital as there can be no resonance without a coupling condition that will permit of but one frequency to which the circuits can be resonated. My view in this respect is in accord with the authorities in the art and with Mr. Marconi's own view, as expressed by him in an address before the New York Electrical Society, April 17, 1912, as reported in the transactions of that society, Nov. 15, 1912, pages 4 to 29, inclusive. At the bottom of page 8, I find that Mr. Marconi in his address stated as follows:

"These two circuits are tuned so as to have approximately the same natural period of electrical oscillation. They then—like tuning forks—have been adjusted in sympathy. It is well known that when using an ordinary spark discharge in the primary circuit, unless weak coupling is employed, the oscillations set up in one circuit create oscillations of two frequencies in both circuits. This has the disadvantage that the radiated energy becomes divided between two waves of different length, and if the receiver is tuned to only one of these wave lengths, it will utilize or absorb only part of the energy reaching the receiver—the energy of the other wave being lost."

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This statement relieves any doubt that Mr. Marconi appreciated that his system required loose coupling between the primary and secondary circuits at the transmitter, in order to obtain one frequency for the proper utilization of resonance. It brings out that Mr. Marconi knew

that resonance was not obtained through merely adjusting the two circuits to have the same natural period of oscillations. He points out that unless the coupling is loose there is no natural period of oscillation, but two frequencies result.

My consideration up to this point shows that the publications prior to the filing of the application for the Marconi patent now under consideration made it necessary for the workers in radio to do little or no guessing as to resonance effects or how to obtain and employ them, and I will not proceed to show how workers prior to the filing of the Marconi application did employ resonance, even including all that is disclosed in the Marconi patent under consideration. [fol. 759] Taking up first Lodge patent 609154 of August 16, 1898, I have shown in a sketch marked "Loftin Sketch L," the radio transmitter and the radio receiver provided by Lodge, the transmitter being based on Figure 4 of the Lodge patent and descriptive matter in the specification, and the receiver being based on Figure 13 of the Lodge patent and descriptive matter in the specification.

I have used the same reference letters as employed in the Lodge patent to facilitate following the Lodge description of operation. At page 2 of the specification, lines 72 to 95, inclusive, Lodge says as to the transmitter:

"The arrangement described with reference to Figure 4 illustrates most completely the method of charging the capacity areas h h' with an impulsive rush. The action is as follows: The Ruhmkorff machine a charges the jars j , whose outer coats are connected, and discharges them at the starting-gap h^{10} . This spark precipitates a discharge at the supply-gaps h^6 h^7 and suddenly supplies the capacity areas h h' with electric charges, which then surge through the connecting coil h' (divided into two parts in this figure) and spark into each other at the discharge-gap between the knobs h^2 h^3 . This last discharge is the chief agent to starting the oscillations which are missible in the arrangements of Figures 3 and 4 to close this last gap when desired, and so leave the oscillations to be started by the sparks at the supply gaps only, whose knobs must in that case be polished and protected from ultra-violet light, so as to supply the electric charge in as sudden a manner as possible."

This statement shows that Lodge, unlike Marconi, did not desire to have oscillations maintained for a long time in the primary circuit. That the purpose of the primary cir-

cuit is merely to provide a place for spark gaps and condensers in which the electrical energy from the source is stored until a sufficient quantity is obtained to be of use for radiation; that the purpose of the spark gaps is to offer a high resistance to hold back energy flow while the condensers are being charged by the source, and when the source is fully charged to let the energy rush into the secondary or antenna circuit. Lodge terms the action as "charging the capacity areas $h h'$ with an impulsive rush." Lodge desired that as soon as the energy was all in the antenna, to have the spark gap open up to prevent energy returning to the primary circuit, for he states "whose knobs must in that case be polished and protected from ultraviolet light, so as to supply the electric charge in as sudden a manner as possible." This shows that Lodge appreciated that ionization in the gap space must be reduced to a minimum in order to have the gap become inactive, for ultraviolet light if permitted to act upon gap electrodes will cause electrons to be emitted by the electrodes. He realized that unless the gaps could be opened up immediately to prevent the return of energy to the primary circuit there would be no sudden effective charging of the antenna, as the charge would immediately return to the primary circuit. The reason for wanting the energy to remain in the antenna after a quick charging is well stated by Lodge at page 2 of the specification, lines 57 to 67, inclusive:

"By both of the means described with reference to Figures 3 and 4, I charge the two capacity areas $h h'$ (which, together with the inductance-coil between them, constitute the radiator) by aerial disruption or impulsive rush. The [fol. 760] advantage of this is that charges so communicated are left to oscillate free from any disturbance due to maintained connection iwth the source of electricity, and therefore oscillate longer and more simply than when supplied by wires in the usual way."

This makes it clear that Lodge well knew that with two coupled circuits the energy would transfer back and forth preventing free oscillations unless the first circuit, the primary, could be effectively removed from the system once the energy it contained had been delivered to the secondary. Therefore, unlike Marconi, he proposed to make his antenna or secondary circuit the seat of oscillations of the desired frequency for transmitting energy to the distant

stations with the primary merely acting to supply the energy without regard to frequency, but only in as quick a manner as possible and then to get out of the way of future action. Marconi made his primary the seat of the oscillations of the desired frequency with the requirement that it remain in action for a long time slowly feeding energy at the desired frequency to the antenna or secondary circuit. Lodge did not have and did not necessarily require adjusting the time periods of the two circuits to be the same. With Marconi's slow feeding he was compelled from the point of view of the efficiency set up as one of his objects to adjust the periods to be the same. Since Lodge only had one circuit, the elevated conductor circuit, involved in the matter of determining the frequency of the oscillations at his transmitter, it was only necessary to tune the receiver to this one circuit, and as to this receiver he states, page 3 of the specification, lines 92 to 101, as follows:

"A receiver or resonator consists of a similar pair of capacity areas connected by a similarly-shaped conductor or self-inductance coil, the whole constituting an absorber arranged so as to have precisely the same natural frequency of electrical vibration as the radiator in use at the corresponding emitting-station, so that it can accumulate the received impulses; that is to say, can act cumulatively."

Thus, having provided for the creation of long drawn-out oscillations of one frequency utilizing the natural period of oscillation of but one circuit at the transmitter, it sufficed to provide a circuit adjusted to the same natural period at the receiver to absorb these long drawn-out one frequency energy bearing waves in a cumulative manner. Referring to my sketch L, Lodge provided variable inductance coils L^1 at both the transmitting and receiving stations for adjusting the natural period of the two circuits to be the same.

As to the particular way of collecting the energy from the receiving antenna for use to affect a detector of this energy, Lodge states, page 4, lines 49 to 61, inclusive:

"In some cases I may, as shown in Figure 13, surround the syntonizing-coil of the resonator with another or secondary coil u (constituting a species of transformer) and make this latter coil part of the coherer-circuit, so that it shall be secondarily affected by the alternating currents excited in the conductor of the resonator, and thus the coherer be stimulated by the current in this secondary coil

rather than primarily by the currents in the syntonizing-coil itself, the idea being thus to leave the resonator freer to vibrate electrically without disturbance from attached wires."

Lodge appreciated, as clearly shown by this quotation, that a coherer or other form of detector was a high resistance device, and if directly included in the elevated conductor circuit that there would be no particular advantage in trying to adjust the natural period of the circuit. When a circuit includes a high resistance element, it is impossible to obtain any sharpness or selectivity of response, so Lodge directed that the resistance detector be removed from the resonating circuit to a mere association with it through a coupling coil, and thus to be secondarily affected instead of directly, and he gives directions for the coupling relation between the two circuits which requires loose coupling, for he states "the idea being thus to leave the resonator freer to vibrate electrically without disturbance from attached wires." In Figure 12 he shows the detector directly connected to the coil h^4 , and in the quotation just given points out that with an inductive form of connection, as is shown in Figure 13, there is less disturbance or reaction on the elevated conductor resonating circuit—that is, that the coupling is loose. I have indicated this in my sketch I. by marking the coupling between the coil h^4 and the coil u at the receiver as loose.

He states further in the matter of making the receiver more effective, page 4, lines 62 and 68, inclusive, as follows:

"In all cases it is permissible and sometimes desirable to shunt the coils of the telegraphic instrument by means of a resistance or a capacity, as shown at w in Figure 12, in order to connect the coherer more effectively and closely to the capacity areas or receiving arrangement whereby it is to be stimulated."

The condenser provided for in this quotation I have shown at w in my sketch I. of the Lodge receiver. Lodge does not definitely direct that the detector circuit be tuned, but this provision of the condenser w provides an element for tuning it, and Lodge's statement that it more effectively connects the detector with the capacity areas, which are the energy collecting means in the primary circuit, indicates that he was directing tuning.

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Whatever gap of doubt that may have been left by Lodge as to the tuning of the secondary circuit of the receiver illustrated in my sketch L was very soon filled by Marconi himself, in his patent 627650 of June 27, 1899, prior to the filing of the application for the Marconi patent now under consideration. This 627650 patent of 1899 covers a receiver having two circuits, and is one of the receivers named in the Marconi specification now under consideration as suitable for use in his four-circuit system. I have illustrated this receiver in a sketch marked "Loftin Sketch M," this sketch being based on Figure 1 of the patent and the descriptive matter in the specification. Marconi states at page 1, lines 14 to 19, inclusive:

"According to this invention the conductor is no longer insulated, but is connected to a capacity, which may be the earth, through the primary of an induction-coil, while the ends of the imperfect contact are connected to the ends of the secondary one of the connections, being through a condenser."

Marconi explains immediately preceding this quotation that an earlier patent of his required the detector to be directly in the antenna circuit. The quotation explains [fol. 762] that his new form of receiver has two circuits—an antenna circuit and a detector circuit. Page 1 of the specification, lines 31 to 37, further states:

"It is desirable that the induction-coil should be in tune or syntony with the electrical oscillation transmitted, the most appropriate number of turns and most appropriate thickness of wire varying with the length of wave of the oscillation transmitted."

Thus Marconi provides for adjusting the number of turns of the induction coil to suit the wave length (or frequency) transmitted, and since he says "for best effects" it means that the adjustment is such that the time period or natural frequency of the antenna is the same as the frequency of the transmitted wave. No other adjustment will give best effects, a matter which has been fully covered by Lodge. Marconi states that the adjustment is attained through choosing an appropriate number of turns of wire on the induction coil. This, of course, does not mean that Marconi intended that each time the wave length is varied a new coil having a new number of turns is to be wound, but that a variably acting coil, such as the coil h^4 of Lodge, disclosed before Marconi, satisfied the requirement. In view of

Lodge's variably acting coil, and the Marconi instructions, I have shown the coil j^1 in my sketch M as variable in the conventional way in present day use, that is, by an arrow. Marconi further says, page 1, lines 38 to 42, inclusive, as follows:

"The capacity of the condenser on the connection between the imperfect contact and the secondary of the coil should be varied (in order to obtain best effects) if the length of wave is varied."

This quotation contains definite instructions to vary the time or natural period of the secondary circuit if the wave length or frequency of the transmitted wave is varied, this time the instructions being to vary the time period through varying the capacity of a condenser, which is the condenser K of Figure 1 and of my sketch M. The quotation states that this adjustment is "in order to obtain best effects," and since best effects are obtainable only through resonance, the instructions clearly are for tuning to the frequency of the transmitted wave. In view of the instructions to vary the condenser K , I have shown this condenser as variable in my sketch M in the conventional way in present day use, that of an arrow drawn through the two condenser plates.

We have therefore in this Marconi patent 627650 a definite receiver tuned to the frequency of a transmitted wave through adjusting the natural time periods of the two circuits to accord with the transmitted frequency, and therefore to each other, and the instructions provide for tuning both through varying inductance and varying capacity. In analyzing what Marconi has done in this earlier patent, it is appreciated that it amounts to no more than following the knowledge of the art in the matter of resonance effects which I have previously referred to.

Up to this point we find that the art is supplied with a system having three circuits, all having their natural periods of oscillation the same as the frequency of the transmitted wave. The first circuit is that supplied in the Lodge patent at the transmitter of my sketch L, in which the antenna or elevated conductor circuit is the seat of oscillations of one frequency, this being the frequency resulting from the natural period of the antenna circuit. The second circuit is that supplied by Lodge at the receiving [fol. 763] station, as illustrated in my sketch L, in which

the antenna or elevated conductor circuit is adjusted to have the same natural period as the elevated conductor circuit at the transmitting station. The third circuit is that supplied by Marconi in 1899, as illustrated in my sketch M, in which the secondary circuit associated with the antenna circuit is tuned to have the same natural period of oscillation as that of the first and second circuits of the system and therefore with the frequency of the transmitted wave. It is also shown that adjustment is attained through varying both inductance and capacity, and that Lodge provided loose coupling at the receiver to prevent unnecessarily large reaction of the secondary circuit on the antenna circuit. There is therefore so far not covered the fourth circuit in the Marconi patent under consideration, namely, the primary circuit at the transmitting station, which is required by Marconi to have the same natural period of oscillation as the three circuits already covered, and which, according to the Marconi specification, is the seat of the oscillations of one frequency maintained for a long time, and therefore is the circuit that sets the pace for the entire system.

This fourth step, however, was provided for in the art prior to the filing of the application for the Marconi patent under consideration. For this next step, I first refer to Tesla patent 645576, of March 29, 1900, issued prior to the filing of the Marconi application. It covers a "system of transmission of electrical energy," and illustrates and describes means for communicating such energy without the use of wire. It is a wireless system. The patent has been severely criticised because it contains suggestions for the transmission of large amounts of energy to great distances through the use of extremely high elevated conductors, when the purpose is large energy transmission, because the suggestions have never been realized in practice. The patent is in no way limited to the transmission of large amounts of energy and employing extremely high elevated conductors, and in its own terms adequately disposes of the criticism to which it has been subjected. For instance, at page 5, of the specification, in lines 24 to 32, inclusive, Tesla said:

"While the description here given contemplates chiefly a method and system of energy transmission to a distance

through the natural media for industrial purposes, the principles which I have herein disclosed and the apparatus which I have shown will obviously have many other valuable uses—as, for instance, when it is desired to transmit intelligible messages to great distances.”

Thus Tesla, while admitting that he is extremely ambitious for his system, yet he does not permit his ambition to deprive it of its usefulness for purposes other than the one he set up as his ideal, and specifically mentions “to transmit intelligible messages to great distances”—wireless telegraphy.

As to the criticism of the extremely high elevated conductors mentioned by Tesla in a number of places when discussing the problem of transmitting large amounts of energy to great distances, he adequately disposes of this when it comes to the transmission of the small amount of energy necessary for transmitting intelligible messages—wireless telegraphy. Page 4 of the specification, lines 105 to 116, inclusive, he says:

“In some cases when small amounts of energy are required the high elevation of the terminals, and more particularly of the receiving-terminal D', may not be necessary, since, especially when the frequency of the currents is very high, a sufficient amount of energy may be collected at that terminal by electrostatic induction from the upper air strata, which are rendered conducting by the active terminal of the transmitter or through which the currents from the same are conveyed.”

Therefore the matter of the height of the elevated conductors was a matter of degree with Tesla, depending upon the amount of energy he wished to transmit. When he thought in terms of transmission of large horsepower for operating motors and lighting cities, he considered elevated conductors of thousands of feet. It is quite natural, therefore, that when thinking of fractions of an erg for operating a sensitive wireless detector, he considered elevated conductors of the order of a hundred feet. While Tesla has been severely criticized, yet every practical worker in the art to-day knows that the higher the elevated conductor the better is distance covered. This is the consideration that led to building towers, eight in number, each 850 feet high, for the Lafayette radio station in France, when, during the war, there was a possibility of the cables being cut

by the German submarines, leaving radio communication as the only communication with the United States. To make communication over this great distance more certain night or day, winter or summer, the designers of the station undertook steel tower construction of unprecedented height in order to get the benefits of great height.

This quotation has also been criticised because of Tesla's theory of the manner of transfer of the energy between the transmitting and receiving stations. After all, it is merely theory, and since the authorities in this art are still grouping and guessing at the real manner of transfer, there can be no objection to Tesla and other early workers in the art having different theories.

The figure of the drawing shows a transmitting and a receiving station, each having an elevated conductor circuit associated with a lateral circuit through an oscillation transformer. At the transmitting station, the source of supply of the high frequency oscillation in the lateral circuit is merely indicated, but in the specification, page 3, lines 118 to 125, the indicated generator G of the drawing is described as a spark gap discharging through a condenser just as described in the Marconi patent under consideration.

Also, page 3, lines 113 to 116, read as follows :

"The transmitting apparatus was in this case one of my electrical oscillators, which are transformers of a special type, now well known and characterized by the passage of oscillatory discharges of a condenser through the primary."

In my sketch A, inserted opposite page 427 of the type-written record of my deposition, I have illustrated the Tesla electrical oscillator referred to in the quotation, and reference to that sketch shows apparatus identical with that of the Marconi patent. In order that it may be appreciated what Tesla means when he says, in that portion of the specification which I have just quoted, that the transmitting apparatus was one of his electrical oscillators of a special type and now well known, I refer to a prior Tesla patent which gives some of the details of construction and adjustment of these Tesla coils, such as the Tesla coil shown in his patent 645576. This prior patent is his British patent [fol. 765] No. 20981 of 1896, and in Figure 13 there is shown a Tesla coil organization adapted for handling large energy.

In this figure the device L L is a rotating break or spark gap. This reference makes clear what is meant by Tesla in his United States Patent 645576, by the term on page 3, line 124, "mechanical operated break." This rotary gap or break is shown in Figure 12. It will be seen in Figure 12 (British patent No. 20981) there is a rotating portion E E-1, consisting of several rotating posts on a central shaft which is driven, as shown in Figure 11, by a suitable motor. Electrodes L L shown in Figure 12 and Figure 13 are held near the rotating spoke arrangement E-1. The object is simply to provide a spark gap device which will give a clean cut discharge where large powers are used. This British patent goes into complete detail as to the organization of apparatus necessary for producing high-frequency oscillations through the discharge of a spark gap in circuit with a condenser and inductance.

Returning to the transmitter illustrated in the figure of Tesla patent 645,576, the specification states, page 3, lines 126-127, that the primary coil C consists of "a single turn of stout stranded cable of inappreciable resistance." This is the same as shown in the single turn of Figure 1 of the Marconi patent under consideration. The secondary winding is described on page 4, lines 3 to 7, as "a flat spiral composed of 50 turns of heavily insulated cable No. 8 wound in one single layer, the turns beginning close to the primary loop and ending near its center."

The Marconi patent also shows the number of turns in the secondary winding to be greater than the number of turns in the primary winding. These descriptions of the coils provide for adequate insulation and for wires of sufficient size to handle large current.

On page 4, referring to the transmitter, the Tesla patent states, commencing line 27:

"The primary and secondary circuits in the transmitting apparatus being carefully synchronized, an electromotive force from two to four million volts and more was obtainable at the terminals of the secondary coil A."

The word "synchronized" used in this quotation has the same meaning as tuning or resonance. There are therefore instructions to tune the primary and secondary circuits together as found in the Marconi specification. It also points out that when in tune a large voltage is obtained in the secondary.

On page 3, commencing line 133, the frequency obtained with the particular apparatus is given:

"That the primary circuit vibrated generally according to adjustment, from two hundred and thirty thousand to two hundred and fifty thousand times per second."

This is a frequency in most general use in radio practice of to-day, particularly for naval ships.

Tesla further states as to proportion for obtaining resonance effects, page 3, lines 58 to 85, inclusive:

"The length of the thin wire coil in each transformer should be approximately one-quarter of the wave length of the electric disturbance in the circuit, this estimate being based on the velocity of propagation of the disturbance through the coil itself and the circuit with which it is designed to be used, by way of illustration if the rate at which [fol. 766] the current traverses the circuit, including the coil, be one hundred and eighty-five thousand miles per second then a frequency of 925 per second would maintain 925 stationary waves in a circuit one hundred and eighty-five thousand miles long and each wave would be two hundred miles in length. For such slow frequency, to which I shall resort only when it is indispensable to operate motors of the ordinary kind under the conditions above assumed, I would use a secondary of fifty miles in length. By such an adjustment or proportioning of the length of wire in the secondary coil or coils the points of highest potential are made to coincide with the elevated terminals D D, and it should be understood that whatever length be given to the wires this condition should be complied with in order to obtain the best results."

Adjusting the length of wire to one-quarter of a wave length, as set forth in the first part of the quotation, is a very common rough or thumb rule used among practical radio workers for obtaining approximate resonance in wire conductors. When the result mentioned in the last part of the quotation is obtained; that is, when the highest potential exists at the elevated terminal, resonance is actually obtained, and Tesla points out that this is the final test irrespective of the thumb rule as to length of wire, and points out that "best results" are obtained when this adjustment is attained; that is, that there is resonance between the elevated conductor circuit and the primary oscillating circuit feeding energy into the elevated conductor circuit.

These considerations of the Tesla patent, issued prior to the filing of the application for the Marconi patent under consideration, clearly shows that Tesla appreciated the necessity for best results of adjusting the time period of the primary and secondary circuits to accord at the transmitter in a wireless or other system of communicating electrical energy through space.

In British patent No. 1862 of 1899 to Braun, there is shown in Figure 4 a two-circuit transmitter. The primary circuit of this transmitter consists of two condensers F F connected in series with a spark gap U and the primary winding of a coil P. There is a secondary winding S inductively associated with the primary T, and the winding S is connected to a radiating circuit M and to either a ground or other capacity area.

British patent 12420 of 1899, in Figure 9, shows a two-circuit receiver, the two circuits being inductively associated through a transformer. These two patents to Braun therefore cover a four-circuit system of wireless telegraphy, two circuits at the transmitter and two at the receiver.

My next reference is to the work of John Stone Stone, commencing in his letter of June 30, 1899, to Baker, defendant's Exhibit F-3, recited in a second letter of July 18, 1899, to Baker, defendant's Exhibit G-3, and covered in United States Patent 714756 of December 2, 1902, the application for which was filed on February 8, 1900. This work of Stone completely covers the four-circuit system of the Marconi patent under consideration from beginning to end, including the tuning of the two circuits at each of the stations, tuning of all four circuits of the system, and the loose coupling necessary to make the Marconi system effective.

[fol. 767] In the Stone letter of June 30, 1899, the opening paragraph generally sets forth why in previous systems, selectivity has not been obtained. The second paragraph of the letter states that the difficulty may be overcome by the use of a system generating simple harmonic waves and capable of receiving simple harmonic waves. The third paragraph reads as follows:

"In the existing vertical wire stations, the waves sent out and the waves received are complex harmonic waves owing to the fact that the vertical wires are not simple resonators, but are capable, upon having their electrical equilibrium abruptly disturbed, of developing oscillations

of a considerable number of different frequencies and also are capable of responding more or less powerfully to a correspondingly large number of different frequencies."

This is the same objection raised by Lodge in his patent 609154 to the single circuit vertical wire system of Marconi. I have already pointed out how Lodge proposed to remedy the defects, particularly in connection with my sketch L.

The fourth paragraph of the Stone letter of June 30, 1899, sets forth the manner in which Stone remedied the defect. He states:

"Instead of utilizing the vertical wire itself at the transmitting station as the oscillator, I propose to impress upon this vertical wire, oscillations from an oscillator, which oscillations shall be of a frequency corresponding to the fundamental of the wire. Similarly at the receiving station, I shall draw from the vertical wire, only that component of the complex wave which is of lowest frequency."

Paragraph 5 then states:

"If now the fundamental of the wire at the receiving station be the same as that wire at the transmitting station, then the receiving station may receive signals from the transmitting station, but if it be different from that of the transmitting station, it may not receive those signals."

Here there are definite instructions to create oscillations of the desired frequency separately and to impress these oscillations upon the vertical wire or antenna, having the antenna's fundamental or natural period of oscillation the same as that of the separately generated oscillations. These are precisely the instructions given by Marconi for his transmitting stations. There are no definite instructions to use loose coupling in order to avoid producing two frequencies, but the very object of Stone was to produce simple harmonic waves, or waves of one frequency, so that loose coupling is necessarily implied, just as in the case of Marconi where he gave no instructions for loose coupling but so stated his object and conditions as to require loose coupling.

The instructions also require adjusting the fundamental or natural period of the vertical wire or antenna at the receiving station to be the same as the vertical wire at the

transmitting station, and directs drawing from the vertical wire only that component of the complex wave which is of lowest frequency. The component of lowest frequency is the fundamental or natural period, and to draw it from the vertical wire requires a lateral circuit of the same natural period as the vertical wire.

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[fol. 768] If a circuit is tuned to the frequency of oscillations in another circuit, it will "draw" energy from that circuit by reason of resonance. On the other hand, if the circuit is not tuned to the frequency of the circuit in which there are oscillations, it will only receive energy through the action of forcing.

The sixth paragraph in the Stone letter of June 30, 1899, states an object the same as that found in the Marconi specification; that is, localization of communication, which means being able to receive communications from one transmitting station without interference from others on different frequencies.

The letter then shows diagrammatically the organization of circuits and apparatus making up the circuit of the Stone system, showing two transmitting stations and two receiving stations. In a sketch marked "Loftin Sketch N," I have reproduced the first transmitting and receiving station shown with the slight exceptions that I have followed the suggestion in Stone letter of July 18, 1899, Figure 2 of the last page, for the location of the spark gap S, this being the preferred location according to the second Stone letter, and is the same location given in the Marconi patent. At the receiving station I insert a condenser C in the secondary circuit, which is in accordance with Stone patent 714756, in numerous figures of that patent such as Figure 6 and Figure 8, and marked in the patent "stopping condenser," and having the same purpose as the condenser j³ in Figure 2 of the Marconi patent, that of preventing the battery D from being short circuited. I have also marked the coupling relation between the primary and secondary circuits at both the transmitting and receiving stations as "loose couplings, and will show in my consideration of the second Stone letter and the Stone patent that he definitely provided for loose couplings. My sketch N is therefore primarily based upon the Stone letter of June 30, 1899, but contains slight modifications in no way effect-

ing the fundamental operation of the system, but being merely preferred forms brought out by Stone in the second letter and the patent.

Reference to my sketch X shows that Stone had organizations at both the transmitting and receiving stations of the Marconi patent under consideration. At the transmitting station he uses a spark gap discharging through a condenser and the primary of an oscillation transformer to create the oscillation of the desired frequency, the frequency being determined by the capacity and the inductance of the circuit. The organization being the same as that of Marconi, the oscillations are persistent or drawn out for a long time. These one-frequency oscillations are impressed upon an elevated conductor circuit, or vertical wire as termed by Stone, though an oscillation transformer. At the receiving station the energy from the space waves is collected on an elevated conductor, or vertical wire as termed by Stone, and through an oscillation transformer impressed upon a second circuit containing inductance and capacity, and having a detector in shunt to a condenser as shown in Figure 2 of the Marconi patent.

[fol. 769] In the paragraph following the diagram, Stone names the devices represented by the reference letters in his diagram, and there can be no dispute that these devices are the same as those shown in the Marconi figures.

The last paragraph but one of the June 30 letter then states:

"The tuning of these circuits one to another and all to the same frequency will probably be best accomplished empirically, though the best general proportions may be determined mathematically."

Such language as this leaves no doubt that the Stone system comprised four circuits all of which had their time or natural periods adjusted to be the same, or, as stated by Marconi, the product of capacity and inductance of all of the circuits was the same. And there can be no doubt that he provided the necessary apparatus for accomplishing this purpose. He clearly shows inductance coils and condensers in all of the circuits, and the art is thoroughly familiar with the manners in which the values of these elements could be changed at will.

The quotation states that it "will probably be best accomplished empirically, which is the method in practical

use and which is the method shown by Lodge in his variably acting inductance coil and by Marconi in the patent under consideration. In general practice, coils for inductance and condensers for capacity are constructed to be capable of having a wide range of value, and when these are inserted in radio circuits the proper values for tuning is determined empirically by turning knobs or moving switches. The operator does not know what value of capacity and inductance he is using, but from the result obtained is satisfied that he has adjusted so as to make the product of capacity and inductance the same throughout. Stone says that the best general proportions may be determined "mathematically." This is done by good designers in determining the necessary inductance and capacity to cover a given range of frequencies at which the set under design is to operate, but once the set is in use in the hands of an operator the tuning for the particular frequency of a particular communication is done empirically by the operator by turning knobs or moving switches.

The second letter of Stone to Baker, July 18, 1899, defendant's Exhibit G 3, begins by going somewhat into detail into the manner of operation of radio systems and develops more specifically than the earlier letter the theory on which Stone based his new system. Having discussed the former system Stone states, commencing bottom of page 4, as follows:

"In my arrangement the vibratory current developed in the vertical wire is not due to the oscillatory discharge of the wire, but is due to a simple harmonic electromotive force impressed upon it which electromotive force produces forced current vibrations in the wire which forced vibrations as is well known depend for their period and form only upon the period and form of the impressed forces, and not upon the electromagnetic constants of the circuit in which they are developed as is the case with free or natural vibrations of a system."

This is a positive statement that Stone intended the primary circuit of his transmitter to be the seat of the oscillations of one frequency, and, having created such oscillations, they would be impressed upon the vertical wire which would be "forced" to accept them at the frequency at which generated by the primary circuit. The action de-

[fol. 770] scribed by Stone in this quoted paragraph is the same as that I have illustrated in my sketch H, the first group of figures in that sketch illustrating the condition obtained when the vertical wire has a natural frequency different from that of the general oscillations, and the lower group of figures representing the condition obtained when the vertical wire has a natural frequency the same as that of the generated oscillations.

Stone then states:

"If the period of the impressed force be the same as that of the fundamental of the vertical wire, then it (referring to the simple harmonic current in the wire) may be represented by $\Lambda_a \sin pt$." [Parentheses mine.]

This equation by Stone is the typical equation of a simple harmonic wave form such as I have illustrated in Figure 5a of my sketch H. The quotation provides for tuning the two circuits together to obtain the result Figure 5a of my sketch H illustrates.

The letter then goes on to state that having obtained a simple harmonic current in the vertical wire of a definite frequency there would result radiation of energy into space at this same frequency, which frequency Stone represents by the letter p .

Beginning at the top of page 6, the letter states:

"I place the coherer at the receiving station in a resonant circuit tuned to the periodicity p . Under these circumstances, the coherer will be operated by the signals sent from the sending station described, but if a second sending station develop radiations or periodicity f , materially different from p , then the receiving apparatus will not be affected by these radiations since the circuit in which the coherer is located is practically opaque to these radiations, or, more properly speaking, to the current which these radiations are capable of exciting."

Here Stone required very careful tuning at the receiver, more particularly in the secondary circuit. Very much sharper tuning is obtainable in the closed type of secondary circuit illustrated by Stone and the Marconi patent than is obtainable through the open type of circuit represented by vertical wire, and this is why Stone at this point lays stress on the tuning of the secondary circuit.

In the letter of June 30 and in his patent he provides for tuning all circuits together.

The next paragraph of the Stone letter is extremely important as it clearly brings out the necessity for loose coupling and his method of obtaining it. It also brings out that as far as the apparatus at the transmitter is concerned, in its general aspects he does not differ from the prior arrangement of Tesla which I have discussed, Stone merely contending that his particular arrangement for obtaining loose couplings which permits him to obtain simple harmonics oscillations differs him from Tesla. The paragraph beginning bottom page 6 of the letter is as follows:

"The first transmitting circuit shown in my letter to you of June 30, is practically the same as that employed by Tesla for high-frequency current, except that I place an inductance coil L in the circuit to give additional means of tuning and to swamp by its greater inductance the reaction from the induction coil t , which would tend to make the oscillations multiperiodic, instead of simple harmonic. The inductance of this coil should be made large compared [fol. 771] to the inductance of the primary t . The use of an auxiliary induction coil for the purpose of rendering the oscillations simple harmonic in the case of circuits connected with other circuits as described above was first made by me and I have elsewhere given a mathematical demonstration of the fact that it accomplishes that purpose."

The quotation lays particular emphasis upon the inductance coil L at the transmitter as shown in my sketch N. It says first that this coil "gives additional means of tuning." It is not shown in the present-day conventional way as variable; that is, with an arrow pointing to a place on the coil, but at the time of Stone's letter and patent no definite conventions were in vogue. He does state that it is for tuning, and in view of the variably acting coil of Lodge before Stone there would be no novelty in making the coil variable in number of turns.

The most important feature of this quotation, however, is that of obtaining loose couplings between the two circuits. Stone states it in the following language:

"The purpose of rendering the oscillations simple harmonic in the case of circuits connected with other circuits."

In my sketch F, Figure 5, I have shown how an auxiliary inductance of this kind provides for loose coupling. In my Figure 5 the coil g^1 is the same as the coil L in the Stone transmitter. My figure shows that the magnetic field is distributed between the several inductance elements of the circuit, and that it is only the field linking with the second circuit that has effect upon the coupling. Stone states that the inductance L in his circuit is large compared to the inductance of the primary of his transformer, which means that the magnetic field of his coil L will be much the larger, and since this field does not effectively link with his vertical wire circuit, the coupling will depend upon the linkage of the small field in the primary of his transformer. The result will be a very loose coupling and a simple harmonic or one-frequency oscillation for all practical purposes instead of a double frequency. Stone says that the large inductance of the coil L "swamps" the small inductance of the primary of the oscillation transformer, meaning simply that the inductance of L being large, the coupling effect of the primary of the oscillation transformer is necessarily small. Stone states that he has elsewhere given a mathematical demonstration of this obtaining of loose coupling through the use of the swamping inductance. This is mathematically demonstrated on page 6 of his patent 714756. There he shows mathematically that the larger the inductance of the auxiliary coils in the circuits, the smaller will be the mutual inductance or coupling between the two circuits.

The letter then, page 7, describes the action in producing the high-frequency oscillations as the discharge of a condenser through a spark gap and inductance just as described in the Marconi specification.

As to the receiving station, the letter states, commencing bottom of page 7:

"At the receiving station the coil L and condenser K form a resonant circuit which is attuned to the frequency [fol. 772] of the current developed at the transmitting station. Again, the inductance of the coil L should be made large compared to the inductance of the secondary of the induction coil t at the receiving station in order to obtain well-defined resonance to a single frequency.

"I believe that I was the first to discover that it was desirable to place an auxiliary induction coil of large in-

ductance in a secondary circuit in order to make it resonant to a definite frequency. I have elsewhere shown that it accomplishes this purpose."

Here Stone provides for inductance coils and condensers for tuning purposes, and necessarily implies that they be variably acting, as tuning can not be accomplished without varying either capacity or inductance to get the desired effect. More, important, however, is his provision for loose coupling, using the same large inductance L as at the transmitter to "swamp" the inductance of the winding in the transmitter to "swamp" the inductance of the winding in the oscillation transformer. It is just as important for selectivity to have a loose coupling at the receiver as at the transmitter. If the antenna or elevated conductor at the receiver is set into oscillation by absorbing energy from space and transfers this energy to a second circuit, two frequencies will be set up as heretofore explained for the transmitter, and it will be impossible to obtain resonance in the secondary circuit. Stone is definite in his requirement of loose couplings, while Marconi is totally silent as to the receiver, not even setting up any objects or conditions as to the receiver that imply loose coupling.

The letter then points out that the second set of transmitting and receiving stations shown in the first letter amounts to a refinement of the system through the use of an additional circuit interposed between the two circuits at the two stations. This second system is one of extreme selectivity but requiring the adjustment of the additional circuit, making it difficult for practical operators to handle an account of the extreme selectivity. In other words, it is too selective for ordinary practice and therefore has not come into any extensive practical use. It does, however, well demonstrate the correctness of the theory on which Stone based his system.

The letter then takes up the matter of a preferred location of the spark gap in a primary circuit at the transmitter, but this is not a matter which affects the fundamental principle of the system.

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Next for consideration is patent 714756 to J. S. Stone, dated December 2, 1902, the application for which was filed February 8, 1900. In its fundamentals this patent covers

the same information as the two Stone letters just considered. It is much more elaborate in detail, fully covering the subject of the Stone system from almost every possible angle. The patent concerns a radio system, for it states, page 1, lines 9 to 13:

"My invention relates to the art of transmitting intelligence from one station to another by means of electromagnetic waves without the use of wires to guide the waves to their destination."

[fol. 773] Figures 5 and 6 show the fundamental system in its simplest form and is the same as the system I have illustrated in my sketch N. Figure 5 is the transmitting station and Figure 6 is the receiving station. Figure 5, like Figure 1 of the Marconi patent under consideration, has a source of supply *a* indicated as an alternating current generator, a key *k* for interrupting the source of supply to make telegraphic signals, an induction coil *M'* having primary winding *P*₁ and secondary winding *P*₂ for stepping up the low voltage of the alternating current generator *a* to a high voltage for charging with a supply of energy a condenser *C*. There is a spark gap *S* which acts to hold back current from the source of supply while the condenser *C* is being charged, and which gap breaks down when the condenser is charged to a high potential and allows oscillations to take place, flowing through the primary of an oscillation transformer *M* having the primary winding *I*₁ and a secondary winding *I*₂ to transfer energy to the vertical conductor or antenna *r* which is connected to earth at *E*. Unlike the Marconi Figure 1, it has a large inductance coil *L* for tuning the primary circuit and for providing for loose coupling between the two circuits, definitely stated by Stone to be for the purpose of securing loose coupling. Marconi, however, has similar provision for loose coupling through the effect of a separate inductance by means of a coil *g* in his antenna circuit. Like Marconi, the frequency of the desired oscillations is determined by the capacity of the condenser *C* and the inductance of the primary of the windings *I*₁ taken with the inductance of the coils *L*. All through the discussion of the Marconi patents under consideration it has been shown that he laid great stress upon making these oscillations in the primary circuit persistent or drawing them out for a long time. In connection with

the discussion of the Lodge patent in suit it was shown that Lodge provided for making oscillations persistent by adding inductance to his circuit. This additional coil L in the Stone patent in the primary circuit, not found in the Marconi patent, makes the Stone arrangement a more certain persistent oscillator than the Marconi arrangement. Like the Marconi Figure 1, the vertical wire v of Stone is an open circuit and therefore a good radiator, as required by Marconi. Like Marconi, the good radiator receives the persistent oscillations of the desired frequency from the primary circuit through slow feeding and also through resonant feeding, as Stone provides for making the fundamental or natural period of the good radiator the same as the frequency of the oscillations generated in the primary circuit. Stone provides an inductance coil I_2 in the good radiator circuit, and since he states that the circuit may be tuned empirically, he had available for empirical tuning the variably acting coil shown in the Lodge patent, which is the same as the variably acting coil shown at g in the Marconi Figure 1.

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In Figure 6 of the Stone patent, the receiving station, there is a vertical wire b which is an open circuit termed by Marconi a "good absorber" of the electromagnetic waves. There is in this circuit an inductance coil I_2 , and since Stone provided for tuning this circuit empirically there is no novelty in making the coil I_2 variably acting as provided for in the Lodge patent in suit. There is an oscillation transformer M comprising a primary winding I_2 and a secondary winding I_1 for transferring energy of the oscillation to the secondary circuit, as shown in Fig-[fol. 774] ure 2 of the Marconi patent. There is a stopping condenser C' corresponding to the stopping condenser $\beta 3$ in Figure 2 of the Marconi patent. There is an inductance coil L corresponding to the inductance coil $g2$ in the Marconi Figure 2, and this inductance coil L is variable as is the coil $g2$ in Marconi, as provided for in the Stone specification, page 6, lines 76 to 81. There is a condenser C around which a detector K is shunted corresponding to the condenser h' with the detector T in shunt in Marconi. There is a battery B corresponding to the battery B in Marconi and a receiver R corresponding to the receiver R in Marconi.

Therefore, Figures 5 and 6 of the Stone patent, comprising his complete four-circuit system, are the same as Figures 1 and 2 of the Marconi patent comprising the complete Marconi four-circuit system, and the Stone figures include all of the elements shown in the Marconi figures, all coordinated to function in precisely the same manner as in Marconi, Stone making it somewhat clearer, however, particularly in the matter of avoiding the production of two frequencies through the use of loose couplings. Each of the two circuits at each of the stations in Stone are tuned to have the same time period and all four circuits of the system have the same time period. Stone provides for generating persistent oscillations in the primary circuit of the transmitter and making this circuit the seat of the one-frequency oscillations upon which the system depends.

I have before stated that the inductance coils *L*, at both the transmitting and receiving stations in Stone were provided for the purpose of tuning, and therefore necessarily implied making them variable acting. In the Stone patent this matter is specifically taken care of, page 6, lines 76 to 81, inclusive, as follows:

"In both the organizations illustrated in Figures 5 and 6, the inductance-coils *L*, may be made adjustable and serve as a means whereby the operators may adjust the apparatus to the particular frequency which it is intended to employ."

In addition to the simple fundamental system Stone shows in Figures 13 and 14 an extension of his system permitting the use of a single vertical wire at both the transmitting and receiving stations on which to impress a plurality of oscillations of different frequencies, commonly known as a system of multiple transmission and reception. It is obvious that in such a system the vertical wire can not be tuned simultaneously to the plurality of frequencies being transmitted and received. Stone says that under such circumstances the vertical wire should be made a periodic—this meaning merely not to attempt to tune it to any one of the frequencies being impressed upon it. In such case the oscillations of the desired frequency in each one of the primary circuits generating oscillations are forced upon the vertical wire, and each one of these forced

oscillations would affect the vertical wire in the manner shown in Figure 4a of my sketch H.

In one part of the Stone specification he states that the "frequency impressed upon the elevated conductor may or may not be the same as the natural period or fundamental of such conductor."

Thereafter he explained that in using a system of multiple transmission and multiple reception with but one vertical wire at each of the stations the vertical wire is not tuned to the oscillations, and this is what I understand him to mean by saying the vertical wire may not be tuned. His specification clearly shows that when his system involves [fol. 775] but a single transmission, all of the benefits of tuning the vertical wire to the lateral circuit should be taken advantage of.

From the point of view of taking every possible advantage of resonance there is a step brought out in the Stone specification, and shown in the figures of his letter of June 30, 1899, which is of extreme importance. Page 8, lines 30 to 32, he states:

"In Figures 6 and 8, the coherers K are shown connected in shunt-circuit to the condensers C and C', respectively."

As previously stated by me, a coherer or other form of detecting device has high resistance, and when inserted directly in a circuit intended for oscillations becomes the controlling factor in that circuit and spoils all attempts to tune through adjustment of capacity and inductance. Stone appears to have been the first to appreciate this fact in the matter of the detector associated with a lateral circuit and took his detector K out of a direct connection in the circuit and placed it in shunt relation to a condenser. This shunt relation allows the capacity and inductance to themselves act upon received current, giving sharp tuning, and the energy is merely transferred to the detector through its connection to one of these elements. This is the arrangement that is in universal use in tuned receiving circuits, and it is shown in all of the figures of the Stone patent. In the Marconi patent the arrangement is illustrated in Figure 2, but an examination of the table of tunes on page 4 shows that Marconi employed it in but one out of the six tunes given.

Reviewing this prior art and the Marconi patent under consideration, I do not find any disclosure in the Marconi patent that was not already available to the art at the time of filing the Marconi application unless it be the single exception of the idea that the primary circuit at the transmitting station should store a very large amount of energy, so much so that it would be impossible to immediately deliver it to the antenna circuit on account of the structure of that circuit preventing it from having sufficient capacity to take all of the energy it was possible to store in the primary circuit. This idea can very well flow out of the language at page 2, lines 6 to 8 of the Marconi specification, as follows:

"The illustrated arrangement of parts at a transmitting station enables much more energy to be imparted to the radiator f ."

and also to the structure shown in Figure 1 of Marconi and in his table of tunes on page 4. The structures invariably show that Marconi used fairly small inductance and large capacity in the primary circuit, and since the amount of energy that can be stored depends upon the capacity, the Marconi structures permitted the storing of larger quantities of energy than did the Stone arrangement, for Stone included a large "swamping" inductance in his primary circuit which necessarily reduced the amount of capacity he could use for a given frequency and therefore the amount of energy that could be stored.

There certainly can be no novelty in the Marconi patent in the matter of tuning, resonance, or syntoncy, because there was no lack of information in the art on this subject. The art cited shows that the time periods of circuits could be adjusted by varying either capacity or inductance, or by varying both, and knew the mathematical relation governing such variation. The art knew from the references I have cited that energy was more effectively transferred [fol. 776] when circuits were in tune through such adjustments. It knew that oscillations had to persist or endure for a long time instead of dying out quickly in order to secure an effective transfer of energy through cumulative resonance. There was information that if two circuits were closely associated one could not oscillate without being materially affected by the other, resulting in reactions, changing the frequency from that which would ordinarily be de-

terminated by the constants of the single oscillating circuit to two entirely different frequencies, and under such circumstances there could be no resonant transfer of energy.

The art cited shows that resonance effects were put into use from the very beginning of the investigations of the transfer of energy through space and without the use of wires. That simultaneously with the development of the use of high-frequency oscillation without wire, high frequencies employing wires as the transmitting medium was developed, and in this development resonance effects were freely and intelligently employed.

The wireless publications before the filing of the Marconi application covering the patent under consideration show that Lodge employed resonance between a transmitting station and a receiving station; that Lodge cut off the oscillations in the primary circuit of his transmitter to avoid production of two frequencies resulting from interaction between two circuits; that Lodge at his receiver removed the detector from the antenna circuit to prevent the detector from interfering with the tuning of the antenna circuit, and coupled the antenna and detector through an oscillation transformer in such a way as to minimize the reaction of the detector circuit on the tuned antenna circuit, and placed a condenser in the secondary circuit to get a more effective relation between the antenna circuit and the detector, undoubtedly through tuning; that Marconi in 1899 added to the Lodge receiver positive instructions to vary the capacity in the secondary circuit to get best results as the wave length was changed or tuning; that Tesla in 1897 provided a transmitter having "synchronism" or tuning between the primary and secondary circuits; and that Stone in 1899 disclosed a complete four-circuit system, resonant throughout, through having the time periods of all of the circuits the same, through creating the oscillations of the desired frequency in a persistently oscillating primary circuit at the transmitter, and made the preservation of resonance throughout the system possible by employing loose coupling between the two circuits at both the transmitter and the receiver; and further by removing the detector from a direct connection in the secondary resonant circuit at the receiver. The Stone apparatus was identical throughout with that of Marconi, including the use of adjustable or variable tuning elements, the only possible difference being the value of one

of the elements, namely, the condenser in the primary circuit at the transmitter, the Marconi condenser being impliedly larger and permitting the storing of more energy.

Applying the prior art to the claims, considering first the group of transmitting claims of the patent under consideration, I do not find that these claims specifically bring out the possible difference I have pointed out that may exist between Stone and Marconi. So far as the specific elements are concerned, they are found in both the Tesla patent and the Stone letters and patent.

[fol. 777] In discussing the Tesla patent I pointed out that Tesla referred in his patent to a generator of oscillations based on prior patents which illustrated an organization of apparatus, such as I have shown in my sketch A, inserted opposite page 427 of the typewritten record. The Stone transmitter I have shown in my sketch N opposite page 715 of the typewritten record.

Claim 1. This claim requires (1) a signaling instrument comprising an induction coil, shown in my Tesla sketch A as the device T, and in my Stone sketch N as the device T; (2) the secondary circuit of which includes a condenser discharging, shown in my Tesla sketch A as the condenser C connected to the secondary S_1 of the induction coil T, and shown in my sketch N as the condenser K connected to the secondary of the induction coil T; (3) a means which automatically causes oscillations of the desired frequency, shown in my Tesla sketch A as the condenser C discharging through the spark gaps dd , and the primary winding P of the oscillation transformer, and shown in my Stone sketch N as the condenser K discharging through the spark gap S and the inductance of coil L and primary winding of the oscillation transformer t ; (4) an open-circuit electrically connected with the oscillation producer aforesaid, shown in my Tesla sketch A as the vertical wire P S_1 E, and in my Stone sketch N as the vertical wire connected to the ground G through the secondary winding of the oscillation transformer t ; (5) a variable inductance included in the open circuit, shown in my Tesla sketch A as the winding S_1 of the oscillation transformer, Tesla having provided in his patent for varying the number of turns in his winding to bring the two circuits in "synchronism," and shown in my Stone sketch N as the secondary winding of the transformer

t. Stone having provided in his letter of June 30, 1899, and in his patent, for tuning this circuit, the letter having stated "empirically," and the usual empirical method being through the use of the Lodge variably acting coil given to the art prior to Stone.

Claim 3. This claim is the same as claim 1 with the addition of two elements; (1) the primary circuit of which includes a generator, shown in my Tesla sketch A as the generator *g*, and shown in my Stone sketch N as an unmarked conventional way of indicating an alternating current dynamo or generator; and (2) means for varying the primary circuit, shown in my Tesla sketch A as either the condenser C or the winding P of the oscillation transformer or both, these both being elements well known to the art as means for varying circuits and shown in my Stone sketch N as the condenser K, the inductance coil L or the primary winding of the oscillation transformer, these all being well-known elements for varying circuits, Stone having mentioned particularly the adjustability of the coil L.

Claim 6. This claim is practically the same as claims 1 and 3, merely describing two of the elements in a different way; (1) a transformer, shown in my Tesla sketch A as the oscillation transformer having primary winding P and secondary winding S₁, and shown in my Stone sketch N as the oscillation transformer *t*; (2) and means for adjusting the oscillation period of each of the two circuits connected with the transformer, shown in my Tesla Sketch A as the condenser C, connected with the primary P of the transformer, a condenser being a suitable element for adjusting the oscillation period of the circuit, and Tesla having referred to changing the period of his circuit through quite a wide range by such adjustment, and by the winding S₁, which is a part of and therefore connected to the transformer, the adjustment being obtainable through adjusting the number of turns in the transformer as well as by a coil separate from the transformer, and shown in my Stone sketch N as the coil L or the condenser K, both connected to the transformer *t*, and both being suitable elements for adjustment, Stone having specifically mentioned adjustability of the coil L; and by the secondary winding of the transformer *t*, this winding being a part of and therefore connected to the transformer, Stone having provided for adjusting this circuit "empirically," and having available

to him the Lodge variably acting coil, the usual device for empirical adjustment.

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Claim 8. This claim is the same as claim 6, except that instead of broadly claiming as in claim 6 "means for adjusting the oscillation period of each of the two circuits" it specifies definitely means in but one circuit, namely, (1) "a variable inductance being included in said circuit," the circuit referred to being the open circuit. This variable inductance is shown in my Tesla sketch A as the secondary winding S_1 , Tesla having provided for varying the number of turns, and shown in my Stone sketch N as the secondary winding of the transformer t , Stone having provided for tuning the vertical wire "empirically," the Lodge variable coil prior to Stone being the usual method of empirical tuning.

Claim 11. This claim is substantially the same as claim 1, except that it adds (1) a signaling instrument in circuit with the primary of the induction coil, shown in my Tesla sketch A as a switch S , which when Tesla suggested a transmission of intelligible messages would be understood by one skilled in the art to be a telegrapher's key switch; and shown in my Stone sketch N as a telegrapher's key or signaling instrument in circuit with the alternating current dynamo. And instead of broadly claiming merely an electrical connection between the two circuits as in claim 1, the claim specifies (2) an oscillation transformer, shown in my Tesla sketch A as the oscillation transformer comprising primary winding P and secondary winding S_1 , and shown in my Stone sketch N as the oscillation transformer t ; and (3) the oscillation transformer electrically connected, at one end to capacity, and at the other end to an inductance, shown in my Tesla sketch A as the secondary S_1 connected to the capacity of earth at E , and since the inductance of the secondary S_1 is a part of the transformer, it is electrically connected thereto; and shown in my Stone sketch N as the secondary winding of the transformer t , one end of which is connected to capacity of earth at G , and since the inductance of the secondary is a part of the transformer, it is electrically connected thereto. Also the Stone sketch shows the provision for dividing the inductance of a circuit into a plurality of parts, for in the sketch N the inductance of the [fol. 779] primary circuit is divided or distributed over two

coils, part being in the primary winding of the oscillation transformer t and part being in the coil L .

Claim 12: This claim is the same as claim 11, except that it specifies that the inductance in the secondary or open circuit be "variable." Tesla instructed varying the number of turns of the secondary winding S_1 , thereby providing a variable inductance. Stone provided for tuning the open circuit "empirically" and the Lodge variable-acting inductance coil prior to Stone provided a suitable means for empirical tuning.

Receiving claims: The receiving claims, as in the case of the transmitting claims, do not broadly claim resonance between the two circuits at the receiver, or having the two circuits adjusted to be in accord in time periods; some of the claims include the means or instrumentalities for adjusting the circuits to accord, and some of them are silent as to these instrumentalities.

Claim 2: This claim includes (1) an oscillation receiving conductor shown in my Lodge sketch L opposite page 694 of the typewritten record as the elevated conductor h , in my Marconi sketch M as the elevated conductor A, and my Stone sketch N as the vertical wire grounded at G; (2) a variable inductance connected with said conductor, shown in my Lodge sketch L as the variable inductance h^1 , in my Marconi 1899 sketch M, opposite page 701 of the typewritten record, as the variable coil j^1 , Marconi having provided in his specification for varying the number of turns of this coil, and in my Stone sketch N, opposite page 715 of the typewritten record, as the primary winding of the oscillation transformer t , Stone having provided for varying the tuning of the vertical wire "empirically," and having the Lodge and Marconi variable coil prior to him as suitable means for empirical tuning; (3) a wave-responsive device electrically connected with said conductor and in circuit with a condenser, shown in my Lodge sketch L as the wave-responsive device e electrically connected to the conductor h through the oscillation transformer having primary winding h^1 and secondary winding u , the same as in the Marconi patent under consideration, and in circuit with the condenser w , shown in my Marconi 1899 sketch M as the detector T electrically connected to the conductor A through the transformer $j^1 j^2$ and in circuit with the condenser K, and shown in my Stone sketch N as the detector C electrically

cally connected to the vertical wire through the transformer t and in circuit with the condenser C .

Claim 13: This claim combines (1) an oscillation transformer, shown in my Lodge sketch L as the windings h^4 and u , in my Marconi 1899 sketch M as the windings j^1 and j^2 , and in my Stone sketch N as the oscillation transformer t ; (2) an open circuit connected with one coil of said transformer, said circuit including an oscillation receiving conductor at one end and capacity at the other end, shown in my Lodge sketch L as the elevated conductor h , which is the oscillation receiving conductor and is open because insulated, and is connected with one coil of the transformer, the coil being connected to the capacity of the earth h^1 at the other end; shown in my Marconi 1899 sketch M as the elevated conductor A connected to the coil at one end and the earth E at the other end; and shown in my Stone sketch N as the vertical wire connected to the transformer t at one [fol. 780] end and the earth G at the other end; (3) a variable inductance being included in said circuit, shown in my Lodge sketch L as the variable coil h^4 , shown in my Marconi 1899 sketch M as the variable coil j^1 , Marconi having provided for varying the number of turns, and shown in my Stone sketch N as the primary of the oscillation transformer t , Stone having provided for tuning the circuit "empirically," and Lodge having provided a variable-acting coil suitable for empirical tuning; the rest of the claim provides for a wave-responsive device in circuit with a condenser as in claim 1, the arrangement being also found in Lodge, Marconi, and Stone as pointed out in claim 1.

Claim 14: This claim is like claims 2 and 13, except instead of specifically including a variable inductance in the open circuit it more broadly specifies (1) means for adjusting the two transformer circuits in electrical resonance with each other, shown in my Lodge sketch L as the variable coil h^4 , one adjustment being all that is required to bring the two circuits into resonance; shown in my Marconi 1899 sketch as either the variable coil j^1 or the variable condenser K, or both, only one adjustment being necessary to bring the two circuits into resonance, but Marconi having provided for varying the number of turns in the coil j^1 and for varying the capacity of the condenser K; and shown in my Stone sketch N as the primary winding of the transformer t or the inductance coil L, or both, only one adjust-

ment being necessary, Stone having particularly mentioned adjustment of the coil *L* and having provided for tuning all of the circuits "empirically," which necessarily implies varying either the inductance or capacity.

Claim 16: This claim is the same as claim 14, except it includes (1) an adjustable condenser in a shunt connected with the open circuit and around said transformer coil, which is an arrangement rarely used in tuning the antenna or open circuit through varying the effect of the coil of the winding which it shunts, and is merely one of the "empirical" methods employed by the art.

Claim 17: This claim is the same as claim 14, except that instead of broadly claiming means for adjusting the two transformer circuits, it includes (1) means included in each of said transformer circuits for adjusting said circuits in electrical resonance with each other. In my Lodge sketch L, Lodge definitely provides the variable coil *h'* in one circuit and implies varying the condenser *w* in the other circuit, as he states that this condenser is for the purpose of obtaining a better connection to the primary circuit, which is obtainable through tuning the two circuits to resonance; shown in my Marconi 1899 sketch M as the variable coil *j'* in the primary circuit, Marconi having provided for varying the number of turns in this coil, and as the variable condenser *K* in the secondary circuit, Marconi having provided for varying this element; and shown in my Stone sketch X, Stone having provided for varying the open circuit "empirically" and having prior to him a variable coil for the primary of the oscillation transformer *t* of Lodge as a suitable means for empirical variation, and Stone having specifically mentioned varying the coil *L* in the secondary circuit.

Claim 18: This claim is the same as claim 17, except instead of broadly claiming means for adjusting each of the circuits, it specifically includes a variable inductance as the means in each of the circuits, shown in my Stone sketch X as the primary winding of the oscillation transformer *t*, Stone having provided for empirical tuning and having the [fol. 781] Lodge coil as a suitable means, and Stone having provided specifically for varying the inductance of the coil *L* in the secondary circuit. Also, once it was made known to those skilled in the art the desirability of adjusting two circuits to resonance, it was within the knowledge of the

art to accomplish it through either varying capacity or varying inductance or varying both.

Claim 19: This claim is the same as claim 18, adding (1) a receiving instrument, battery, shown in my Lodge sketch L as a receiving instrument *g* and battery *f*; in my Marconi 1899 sketch M as a receiving instrument R and battery B, and in my Stone sketch N as a receiving instrument *r* and battery B.

Claims covering both stations: There are two of these claims in suit and, as heretofore noted, one of them is the only claim out of all of those in suit that broadly claims having the circuits in resonance. This claim specifies that all four circuits of the system are in resonance. The other claim limits itself to the means or instrumentalities for bringing the circuits into resonance.

Claim 10: This claim includes (1) a transmitting station and a receiving station each containing an oscillation transformer, shown in my Tesla sketch A as a transmitting station having an oscillation transformer, and my Marconi 1899 sketch M as a receiving station having an oscillation transformer, or in my Stone sketch N as a complete system in one showing, at both of which stations there are oscillation transformers; (2) one circuit of which is an open circuit and the other a closed circuit, shown in my Tesla sketch A as an open and closed circuit at the transmitter and in my Marconi sketch M as an open and closed circuit at the receiving station, or in my Stone sketch N as a complete system each station having an open and a closed circuit; (3) the two circuits at each station being in electrical resonance with each other and in electrical resonance with the circuits at the other stations, shown in my Tesla sketch A as two circuits at a transmitting station in electrical resonance with each other and in my Marconi sketch M as two circuits at a receiving station in electrical resonance with each other, making a complete system in which it follows that all four circuits are necessarily in resonance; or in my Stone sketch N, which is a complete four-circuit system having two circuits at the transmitting station in electrical resonance and two circuits at the receiving station in electrical resonance, and four circuits of the system in electrical resonance as stated by Stone in his June 30, 1899, letter as follows:

"The tuning of these circuits one to another and all to the same frequency will probably be best accomplished em-

pirically, though the best general proportions may be determined mathematically."

Claim 20: This claim is the same as claim 10, except that instead of broadly claiming that the circuits are in electrical resonance it merely claims the means or instrumentalities for adjusting the circuits, but does not add anything not included in the transmitting and receiving claims I have already discussed and have shown to have existed in Tesla, Lodge, and Marconi in 1899, or which is not included in the complete four-circuit system of Stone illustrated in my sketch M, and there is no necessity for pointing out these various devices in repetition over my discussion of the transmitting and receiving claims.

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[fol. 782] 28. Question. Does the file wrapper and contents of the Marconi patent No. 763772 indicate whether or not the prior art to which you have referred was considered by the Patent Office, and if so, does such file wrapper indicate the reasons upon which the allowance of the application was predicated?

Answer. I have examined the file wrapper and contents of the Marconi patent 763772, and find that the Patent Office considered the prior art to which I have referred with one exception, namely, the letters of Stone to Baker of June 30, 1899, and July 18, 1899, and that the examiner who first handled the case and continued to handle it for more than three years repeatedly and consistently rejected it on this art.

The application was filed on November 10, 1900, and on July 1, 1901, the entire original specification and all of the claims were canceled and a new specification and set of claims substituted following a rejection of the *the* original claims by the examiner.

Following the filing of the new specification the claims were repeatedly rejected on early art not referred to by me. Commencing in its office letter of February 11, 1902, the Patent Office began to reject on the art which I have referred to, citing on page 4 of the letter the British patent to Braun, the Lodge patent 609154 in suit, and the Marconi patent 627650 of 1889. In reply to an amendment by Marconi the Patent Office then rejected on June 3, 1902, all of the claims on Tesla 645576 of March 20, 1900, referred to

by me, the examiner stating on the last page of the letter of June 3, 1902, as follows:

"Claims 4, 13, 14, and 16, which specify a variable inductance and means for adjusting the inductance, are not patentable over Tesla because Lodge, of record, has shown that it is old to adjust the period of a circuit by a variable inductance; and claims 3 and 5, which specify an adjustable condenser, are not patentable over Tesla because applicant has shown in his prior patent 627650, that this adjustment may be produced by a variable condenser."

In other words, the examiner contended that there could be no novelty in merely providing two circuits having their time periods adjustable to be the same as Tesla had shown these circuits and provided for their adjustment in general language, and there could be no novelty in specifically claiming the adjustable elements as Lodge and Marconi himself had supplied these. The examiner on the same page of the letter of June 3, 1902, gives the practical reason for crediting to the Tesla system the use of the adjustable inductance of Lodge or the adjustable condenser of Marconi as follows:

"Since it is impossible to exactly calculate the values of the electro-magnetic constants of two circuits for the purpose of making their time period agree, it is fair to assume that the electrical oscillator of Tesla must necessarily be made with an adjustable inductance or condenser, or both."

This statement of the examiner is quite the same as that in the Stone letter of June 30, 1899, last page, as follows:

[fol. 783] "The tuning of these circuits one to another and all to the same frequency will probably be best accomplished empirically, though the best general proportions may be determined mathematically."

Thus Stone and the examiner at practically the same period of the development of the art agreed that it would be foolish to try to determine the exact proportions for adjustment mathematically; that for practice the general proportions could be so determined, leaving the specific adjustment within the general proportions to be determined by some empirical means such as the variable coil of Lodge and the variable condenser of Marconi.

This office action of June 3, 1902, resulted in Marconi letting his application become abandoned, for no reply was made within the year required under the Patent Office rules.

On October 6, 1903, 16 months after the office letter rejecting the case, Marconi filed a petition to the Commissioner of Patents for revival of the case, together with a proposed amendment and a reply to the examiner's arguments on rejection. On October 15, 1903, the examiner in a statement to the Commissioner of Patents recommended that the petition for revival be denied. Additional affidavits were filed by Marconi subsequent to the examiner's statement, and these were also considered by the examiner, and in a statement to the commissioner his recommendation for denial of the petition was persisted in. On December 3, 1903, the Commissioner of Patents formally denied the petition for revival.

In the examiner's statement to the commissioner of October 15, 1903, he persists in his contention that the claims are not patentable over Tesla, and further adds prior art considered by me in the way of the paper of Pupin presented before the American Institute, December, 1899, and the Stone patent No. 714756.

In the Marconi amendment accompanying the petition he contended that the Tesla oscillator was not the same as Marconi's oscillator consisting of a spark gap, condenser, and inductance in circuit. The examiner on page 5 of his statement comments on this as follows:

"Many of the claims are not patentable over Tesla 645576 and 649621, of record, the amendment designed to overcome said references as well as Marconi's pretended ignorance of the nature of a 'Tesla oscillator' being little short of absurd. Ever since Tesla's famous lecture on alternating current of high frequency delivered before the American Institute of Electrical Engineers in 1891, and repeated in 1892 before the Institute of Electrical Engineers and the Royal Institution, London, the Societe Internationale des Electriciens, and the Societe Francaise de Physique, Paris, which lectures have been widely published in all languages, the term 'Tesla oscillator' has become a household word on both continents."

The examiner then points out that this Tesla oscillator was found in all elementary textbooks used in the ordinary

high schools, and that Marconi evidently knew of it in 1897, because he is quoted by Della Rictia in a publication in 1898 as having used it.

In concluding the Examiner said:

"It is true that said British patent (referring to Marconi British patent No 7777 of 1900 corresponding to the application then under discussion) as well as other foreign patents so operates and it is true that this is a valuable invention, but, in the opinion of the examiner, the references above cited and also numerous other references, some of [fol. 784] which are hereinafter set forth, effectually dispose of the idea that this is a valuable application, however valuable may be the invention disclosed therein, because any patentable claims which this application will support in view of the state of the art must necessarily be of the most limited character." [Parentheses mine.]

This statement of the examiner of October 15, 1903, having included reference to both the Pupin paper and the Stone patent, brings in all of the prior art that I have referred to; that is, prior art relating to radio communication per se, except the two Stone letters.

Following the denial of the petition for revival on December 2, 1903, by the Commissioner of Patents, Marconi, on February 19, 1904, requested a reconsideration of the petition, which petition was granted on March 28, 1904, by the Commissioner of Patents, there being no evidence in the file wrapper that the petition for reconsideration was submitted to the examiner, and there is no statement from the examiner to the commissioner included in the file wrapper.

Following the revival of the application by the commissioner, the case was immediately acted upon by a new examiner, and all of the claims formerly rejected by the old examiner allowed, except four, which were rejected on the patent to Stone 714756, which I have referred to.

The new examiner said as to these rejected claims:

"Stone shows in Figure 5 a transformer M whose secondary I^2 is connected to an open circuit including a radiating conductor V at one end and a capacity E at the other and whose primary I^1 is connected to a condenser circuit discharging through a spark gap, viz, a circuit, C, s, P, L. These circuits are in 'electrical resonance with each other'. See lines 16-20, page 2. It is not stated how the elevated

conductor is given a natural period equal to that of the oscillations impressed upon it but it is well known by all skilled in this art that this may be accomplished by adjusting the length of the elevated conductor, thereby adjusting the distributed capacity and the distributed conductors of the same until the natural period of such conductor is equal to the natural period of the condenser circuit C, s, P, L. When this is done 'the frequency impressed upon the elevated conductor' is 'the same as the natural period or fundamental of such conductor', to quote from the Stone patent."

Thus, the new examiner limited the tuning in the vertical wire or elevated conductor circuit through an adjustment of the physical length of the wire, though there is no statement in Stone which so limits it, and is a view contrary to that expressed by the former examiner who said that in view of the prior Lodge patent, there was no invention in employing for the purpose of tuning the vertical wire of Stone the variable-acting coil of Lodge in the manner shown by Marconi.

As I have heretofore stated, the Stone to Baker letters were not considered by the Patent Office. Had the Stone letter of June 30, 1899, been before the examiner, it is my opinion that his contention that Stone was limited to varying the physical length of the vertical wire would have in no wise been tenable in view of Stone's statement on the last page, as follows:

"The tuning of these circuits one to another and all to the same frequency will probably be best accomplished empirically, though the best general proportion may be determined mathematically."

[fol. 785] This very complete statement of Stone certainly invites the attention of the art to the empirical variable acting coil of Lodge or the empirical variable condenser of Marconi referred to by the former examiner.

Having interpreted this limitation into the showing of the Stone patent, the new examiner said:

"Applicant discloses another means whereby the same result may be effected, viz, by including a 'variable inductance' in the elevated conductor. All claims which include this element are considered allowable over the Stone patent."

It therefore appears that the only difference the new examiner could find between Marconi and the prior art I have referred to was the placing of the Lodge variable acting coil in the elevated conductor circuit of Tesla and Stone, and it is my opinion that even disregarding the fact that the examiner did not have before him the Stone letter of June 30, 1899, that this is an extremely narrow difference particularly in view of the examiner's statement in the paragraph immediately following, as follows:

"In regard to claim 7, it may be said that Stone states that the operator at each station may at will adjust his apparatus in such a way as to place himself in communication with any other station (page 4, lines 28-36), and that he also states that this result may be effected by making the coil L of the condenser circuit adjustable (page 6, lines 76-81). Inasmuch as the period of an oscillating circuit depends upon the capacity of the condenser in the same way that it depends upon the inductance of the coil, it is held that it is not patentable to make the condenser *c* of applicant's oscillating circuit adjustable for the same purpose as Stone makes the coil L of his oscillating circuit adjustable."

Here the examiner held, in considering one circuit only, there would be no invention in shifting from a variable inductance to a variable condenser, which does not seem to be in keeping with the very narrow view taken as to the latitude of the manner of adjustability of the vertical wire circuit of Stone.

Summarizing the question, I find that all of the radio art I have referred to was considered by the Patent Office except the Stone-Baker letters of June 30, 1899, and July 18, 1899, and that the file wrapper indicates as the sole reason upon which the allowance of the application was predicated was the contention of the second examiner that Stone probably intended turning his vertical wire through varying its length, and Marconi having shown the Lodge variable acting coil as a tuning means for his vertical wire he was entitled to claim it.

Disregarding the Stone to Baker letters, there could be, in my opinion in view of the state of the art, no inventive novelty on the part of Marconi in using the variable-acting tuning coil of Lodge in Marconi's antenna. Lodge had

shown the coil in an antenna circuit or vertical wire for tuning, and Stone specifically states in his patent that the vertical wire may be tuned, and I can see no reason for the examiner contending that Stone should be limited to the awkward and unpractical method of trying to add or subtract wire at the top of an elevated wire instead of employing the practical method of a variable-acting coil provided by Lodge easily placed within reach of the operator. The Lodge method was certainly obvious to one skilled in the [fol. 786] art reading the Stone specification. However, it is clear to me that the entire matter was settled by the Stone to Baker letter of June 30, 1899, not before the examiner, in view of Stone's most specific instruction for empirical tuning.

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29. Question. Compare the apparatus illustrated in plaintiff's Exhibit No. 87, Wireless Specialty Apparatus type, and described in the testimony of plaintiff's witnesses, with the apparatus of the Marconi patent 763772 to which you have referred, and explain wherein the function and mode of operation of the two types of apparatus are similar or dissimilar.

Answer. I have examined plaintiff's Exhibit No. 87, Wireless Specialty Apparatus type, and the description of this apparatus in the testimony of plaintiff's witnesses together with plaintiff's Exhibits No. 60, Navy contract No. 133; Exhibit No. 62 and Exhibit No. 87A referred to by the witnesses in their testimony concerning this type. Considering first the transmitting station of the Wireless Specialty Apparatus type, I find that the apparatus illustrated in plaintiff's Exhibit 87 and described by the witnesses and the exhibits is an apparatus which functions and has a mode of operation entirely different from the transmitter of the Marconi patent 763772.

I note that plaintiff's witness Langley describes the spark gap G at the transmitting station as of the type now known as "quenched" type, and that plaintiff's witness Waterman at page 165 of his deposition quotes from plaintiff's Exhibit No. 60 as to the gap as follows:

"Quenched spark gap, new design, perfect cooling by special central drafts. (We reserve right to furnish our new type tubular gap.) This latter having new feature

of cooling and perfect sparking alignment with ease of dismantling."

Also on the same page Mr. Waterman quotes from plaintiff's Exhibit No. 60, Navy contract of September 21, 1912, as follows:

"Wireless Specialty Apparatus Co. proposes to furnish apparatus as per the following details: * * * transmitting inductances will be supplied giving continuously variable wave length of 600 to 2,000 meters with no switches, exciting and radiating circuits, always in resonance and with maximum coupling."

The first quotation very definitely describes a type of gap, and the second quotation the kind of circuits forming the two circuits at the transmitting station and the manner of their association so as to make it clear and beyond all doubt that the transmitting station is the system described in United States patent 1216615 to G. Seibt, for "Apparatus for producing powerful electrical oscillation," granted February 20, 1917, on an application filed December 27, 1909. The system disclosed in the Seibt patent has since its introduction by Seibt and others become universally known as the "quenched gap" system, as well as having been universally adopted to take the place of all other types of damped wave or "spark" radio transmission. Fundamentally, it is based on the system disclosed by Lodge in his patent 609154 of 1898, particularly the transmitter [fol. 787] illustrated in Figure 4 of the Lodge patent, and broadly stated at page 2 of the Lodge specification, lines 57 to 67, inclusive, as follows:

"By both of the means described with reference to Figures 3 and 4, I charge the two capacity areas b b' (which, together with the inductance-coil between them, constitute the radiator) by aerial disruption or impulsive rush. The advantage of this is that charges so communicated are left to oscillate free from any disturbance due to maintained connection with the source of electricity, and therefore oscillate longer and more simply than when supplied by wires in the usual way."

Thus Lodge laid down the principle of quickly imparting a large amount of energy to the antenna or radiating circuit and then removing or electrically disconnecting the

source of supply of the energy from the radiating circuit so that the energy could oscillate at the natural period of the radiating circuit unhampered through any maintained connection or association with the supply circuit. In the Lodge system the radiating circuit is the seat of the oscillations and determines the frequency for the entire system, and is entirely unlike the later system of Marconi in which the primary circuit is the seat of oscillations and determines the frequency, the radiating circuit merely being a stepping-stone in the Marconi system slowly taking energy from the primary circuit in small quantities to prevent interaction between the circuits, and having the amount of energy given it by the primary circuit and the duration of the giving dependent upon the characteristics of the primary as a reservoir and a good conserver. In the Lodge system, the primary circuit has nothing to do with the frequency and the duration of the oscillations, this being the function of the secondary or radiating circuit, the function of the primary circuit being merely to collect a considerable quantity of energy, deliver it to the radiator circuit in the least possible time, and finally to entirely get out of the way the radiating circuit when the latter goes into action. On the other hand, in the Marconi system, the primary circuit is entirely responsible for setting the frequency of the system and for the duration of the oscillations, and can never forsake the secondary circuit, as the secondary circuit's function in the system is entirely dependent upon the primary circuit.

The quenched gap system described by Seibt is an improvement upon the Lodge system, predicted, first, upon recognizing certain principles in connection with the action of spark gaps in the matter of ionization and, second, upon utilizing to advantage the production of two frequencies between two closely coupled circuits, which two frequencies were entirely destructive to the Marconi system.

In my two quotations from Mr. Waterman's deposition on page 165 I showed that in the first quotation Mr. Waterman pointed out that the Wireless Specialty Apparatus type of apparatus, plaintiff's Exhibit 87, contains, first, a quenched gap, which is the first improvement in the Seibt system over Lodge, and from the second quotation contains, second, "maximum" or tight coupling, together with means for bringing the two circuits in what was termed in the quotation "resonance," which coupling and so-called

"resonance" relation constitutes the second basis of Seibt for improvement over Lodge. I will point out in connection with my discussion of the operation of the Seibt and Wireless Apparatus Co. type that there is no such thing [fol. 788] as "resonance" between the primary and secondary circuits of the quenched gap type. That the adjusting of the time period of the two circuits is for a purpose having nothing whatever to do with a resonant transfer of energy between circuits as was necessary to the success of the Marconi system.

In my sketch G, Figures 2 and 2a, I have shown the two frequencies resulting from tightly coupling two oscillatory circuits together, and have illustrated the two oscillations in red and green to show that there are two, and I have pointed out that neither of the frequencies of the two oscillations is the same as that of the natural time period of the circuit, but entirely different, one being of a frequency higher and one of a frequency lower than the natural period. I have also shown that under such conditions of association the energy is transferred back and forth between the two circuits, being alternately all in one circuit, and all in the other circuit, giving beats of no energy in the two circuits from time to time. In the Seibt patent I have referred to this effect is also clearly shown in Figures 2 and 3, except that Seibt makes no effort to show by colors or otherwise that there are two frequencies in each circuit, the patent being principally concerned with the point at which the first beat is obtained. In the specification Seibt describes this action, page 1, lines 62 and 70 as follows:

"In the arrangement shown in Figure 1 two separate oscillations are produced, as is well known, even though the natural periods of the two circuits, I and II, are the same. In the case where these two circuits are in resonance with respect to their natural periods, the two wave lengths of the system are given by the following formulae, neglecting resistance—".

Seibt then states the two formulae for the two wave lengths or frequencies which I have previously given. I wish to point out that Seibt's reference in this quotation to "resonance" between the two circuits carefully avoids any interpretation of a resonant transfer of energy, for

he states "resonance with respect to their natural periods," meaning merely that as far as adjustment of capacity and inductance is concerned, the products are such as to make the natural periods of the circuits, if acting alone, the same. There is no resonance, and can be none, with respect to the frequencies of the two oscillations set up.

Seibt then describes the production of beats, or alternate periods of no energy in the two circuits, illustrated by me in my sketch G and by Seibt in his Figures 2 and 3, as follows:

"In Figure 2 I have shown the form of the oscillations set up in the primary Circuit I, and in Figure 3 I have shown the form of oscillation induced or set up in the coupled secondary Circuit II. An examination of these diagrams reveals the fact that in the beginning when a spark discharge takes place in circuit I there is no energy in Circuit II, and consequently the oscillations in Circuit I commence with maximum amplitude, while the amplitude of the oscillations in Circuit II commence with zero value. The energy in the primary oscillating Circuit I, however, sets up oscillations in Circuit II, so that, commencing with zero value at the beginning, the amplitude of the two oscillations in Circuit II increase, as the corresponding amplitudes of the oscillations in Circuit I decrease, thereby producing beats, the energy in Circuit II influencing the Circuit I and again setting up oscillations therein, but of diminished value to the extent of the damping that takes place in the transformation from the one circuit to the other. These resulting oscillations of diminished energy commence at zero value of amplitude and built up again in amplitude, in Circuit I as the oscillations in Circuit II diminish in amplitude, but the maximum value of the oscillations of the second beat in Circuit I is less than the maximum value of oscillations in said circuit at the commencement of the operation; that is, at the time of the discharge at the spark gap. In turn these oscillations of diminished maximum amplitude in Circuit I again set up oscillations in Circuit II, but also correspondingly reduce maximum amplitude, and so on, till the oscillations in both circuits are finally reduced to an infinitesimal value."

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Thus Seibt describes the transfer of energy from one circuit to another alternately in a tightly coupled system

in the same manner as I have previously explained both in connection with electrical circuits and coupled oscillating bodies such as pendulums.

By reference to Figures 5 and 5a of my sketch II, it will be seen that in a loosely coupled, persistently oscillating primary circuit system of the Marconi type, there is no production of beats or instances of no energy in the two circuits as is had with a tightly coupled system.

Now, it is this beat phenomenon that attracted the attention of Seibt and other workers in the radio art in the years just prior to the filing of the Seibt application. It occurred to them that this point of no energy in the primary circuit could be put to a useful purpose, namely, giving the spark gap sufficient time to become adequately deionized to permit the gap to open or become inactive, thereby disconnecting the primary circuit electrically from the radiating circuit, so that no retransfer of energy could take place, and the energy all being transferred to the radiating circuit would remain there and continue to oscillate at the frequency natural to the radiating circuit until expended. Seibt describes this result at page 2, lines 74 to 87, as follows:

"From the moment of this snapping off of the current at the spark gap, or the resulting opening of the primary circuit, the secondary circuit takes up an independent oscillation, uninfluenced to any appreciable degree by the coupling thereof to the primary circuit, the character of the oscillations therein being changed so that the two coupled waves ϵ_1 and ϵ_2 disappear and the free oscillation ϵ_0 alone, of the secondary circuit takes place, this free oscillation being of slowly damped form and depending on the natural period of the secondary circuit."

Thus, while energy is being transferred from the primary to the secondary circuit there exists no useful frequency for radiating one frequency waves, but two arbitrary coupling frequencies which, through being different, act to create [fol. 790] a beat or point of no energy in the primary circuit. The real frequency useful to the system does not commence until all of the energy is transferred to the radiating circuit and the primary circuit then electrically disconnected from the radiating circuit through an opening of the spark gap, termed by the art "quenching," from

which the name of the system is derived. Seibt illustrates the oscillations resulting in the radiating circuit from a quenching of the spark gap at the first beat in the primary circuit in Figure 4 of his patent. In a sketch marked "Loftin Sketch O—Quenched Gap System," inserted opposite, I have illustrated the effect described by Seibt in the quotation above, and have shown the two coupling frequencies in red and green as in previous sketches, and the desired one frequency of the system obtained in the radiating circuit in purple. The Seibt quoted description above clearly brings out that there are two frequencies up to the point of quenching, but no effort has been made to show this in his Figure 4 as I have done in my Figures 6 and 6a of my sketch O. In my Figure 6 I show the oscillations in the primary circuit, and by carefully examining this sketch, it will be seen that the red and green oscillations commence at about the same time, or what the art terms "in phase," but being of different frequencies, they gradually pull apart until they become opposed, termed by the art "opposite in phase," which occurs at the beat or point of minimum current, and by examining my Figure 6, it will be seen that at this point, the red oscillation is below the line and the green oscillation above the line. If the strength of the two oscillations at this point is exactly equal, one will cancel the other and there will be a period of absolute zero current having the duration of one-half cycle of the high frequency. This, of course, is a very short time when calculated in seconds, but with a spark gap properly designed so that electrons traveling at the rate of 185,000 miles per second can all, or practically all, escape from the space separating the electrode, it will be appreciated that this very short period of no current can be very usefully employed in bringing about "quenching," so vital to the quenched gap system. I will explain later the requirement for a gap suitable to operate in such a system.

In my Figure 6a the oscillations in the secondary or radiating circuit are illustrated, and I have drawn the oscillation directly below those in the primary circuit to indicate what happens in the secondary at instances corresponding to the primary. It will be seen by careful examination that when the red and green oscillations in the primary are large and in phase, that the red and green oscillations in the secondary are small and opposed, and that as the

red and green oscillations in the primary gradually become smaller and draw out of phase, the red and green oscillation in the secondary gradually become larger and draw in phase, meaning that the energy transfers from the primary to the secondary. At the point of minimum energy in the primary where the gap "quenches," the influence of the primary on the secondary then ceases, the primary being unable to support current flow and therefore to take no energy from the secondary. The energy of the red and green oscillation in the primary then combines to form one powerful oscillation in the secondary, which I have illustrated by showing the purple oscillations commencing at this point as being much stronger than either the red or green oscillations, it having the combined energy of the two oscillations. The purple oscillations in the radiating [fol. 791] circuit then continue as a long drawn out train of oscillations having the frequency set by the natural period of the radiating circuit, the strength of the oscillation gradually decreasing as the energy is imparted to the surrounding space for useful communication of signals, together with a small loss in overcoming the resistance of the wire forming the radiating circuit.

It is seen that this is a system entirely different from that described by Marconi, which Marconi system has been termed by the art the "open gap" system, and by which term I will refer to it in the future for the sake of brevity. In the open-gap system, no beats are produced, first, because it is required that the primary circuit determines or sets the pace for the one frequency of the system, and to produce beats there must be two frequencies; second, because the primary must be persistent and have its oscillations drawn out for a long time, and it can not be persistent if it quickly transfers all of its energy to the secondary to produce the beat required in the quenched gap system, and the oscillations in the primary will not be long drawn out; third, because in the open-gap system, the primary must act as a reservoir and slowly feed energy to the secondary to persistently make up for the energy expended by the secondary in radiating for useful communication, whereas in the quenched gap system the energy is quickly dumped into the secondary during which period there is no useful radiation, and when the secondary is usefully radiating, the primary is entirely out of action and supplies no energy; and fourth, there must be a resonant transfer of energy

between the primary and the secondary in the open-gap system, because the primary is always and continuously supplying energy at a particular desired frequency to the secondary, and the secondary must have the same natural period of oscillation as the frequency of the oscillation from which it is being fed to obtain an efficient transfer at the slow rate of feeding, whereas in the quenched gap system there is no resonant transfer, the energy merely quickly going over at two widely separated frequencies, neither one of which corresponds to the natural period of either the primary or secondary circuit.

In Figure 6*b* of my sketch O, I illustrate the radiated result of the oscillations in the radiating circuit of the quenched gap system illustrated in Figure 6*a*, the diagram showing signal strength plotted against frequency, signal strength being represented by vertical dimensions and frequency by horizontal dimensions. The diagram shows that during the period of transfer of energy between the primary and secondary circuit, there are radiated two weak signals, one in green at a frequency lower than the desired frequency and one in red at a frequency higher than the desired frequency. These two signals are not very strong because the time of transfer is very short, and also the energy is divided between two frequencies. The diagram shows the radiated signal of the desired frequency in purple, as being considerably stronger than the signals resulting from the two coupling frequencies, this on account of the energy at the desired frequency enduring for a long time and being the combination of the energy of the two coupling frequencies. The desired frequency illustrated in the diagram is the frequency determined by the natural period of the radiating circuit, and is in no way derived from the period in the primary circuit, and when received by a two circuit receiving station having its two circuits [fol. 792] tuned to this frequency, the system is a three circuit tuned system instead of a four circuit tuned system as in the open gap system.

The signal diagram in my sketch O, is the same as that illustrated in Figure 6 of the Seibt patent, the two small humps marked as ϵ^2 and ϵ^1 in the Seibt diagram, indicating the green and red coupling frequencies in my diagram.

Comparing the quenched gap system of my sketch O with the open gap system of my sketch H, Figures 5, 5*a*, and 5*b*,

the differences in the two systems are readily apparent. Figure 5 of the open gap system shows powerful oscillations of long duration and without beat, and of one frequency in the primary circuit, while Figure 6 of the quenched gap system shows two oscillations, each relatively weak and with a quick beat, and of short duration in the primary circuit. Figure 5*a* of the open gap system shows relatively weak oscillations in the radiating circuit, first gradually building up, and then decaying, being weak because of the slow feeding from the primary circuit, and having the same frequency as the oscillations in the primary circuit, while Figure 6*a* of the quenched gap system shows first, oscillations of two frequencies, which quickly combine to form oscillations very powerful and of one frequency not found in the primary circuit, being powerful on account of comprising practically all of the energy of the system quickly dumped into the circuit by the primary. Figure 5*b*, the signal diagram of the open gap system, shows signals of one frequency corresponding to the frequency of the primary circuit, and being relatively weak because produced by the more or less oscillations in the radiating circuit, while Figure 6*b*, signal diagram of the quenched gap system, shows two relatively weak signals at widely separated frequencies resulting from the tight coupling between the primary and secondary circuit during the period of dumping of energy into the secondary circuit, and one very powerful signal of the desired frequency corresponding to the frequency determined by the radiating circuit and not found in the primary circuit.

The foregoing clearly brings out that the quenched gap system is based upon the fundamental principles laid down by Lodge which I have previously quoted, namely, quickly dumping amount of energy into the radiating circuit, and as soon as this — accomplished to electrically remove the dumping source from a maintained connection with the radiating circuit in order that the radiating circuit may be free to form this energy into a long drawn out train of very powerful one frequency oscillations.

Considering now my discussion of the quenched gap system, the following quotation from the Seibt patent, page 3, lines 6 to 24, inclusive, become particularly significant:

"From the foregoing considerations it will be seen that in practical operation it is desirable that the spark snaps

off, or is quenched, or, in another expression of the idea, that the primary circuit is opened, at the instant when the current amplitude first reaches zero value in the primary circuit, or at the spark gap, and that the duration of the spark be as short as possible, that is, that the coupling between the circuits shall be sufficiently strong or close and adjusted to secure a rapid decrease of the oscillations in the primary circuit with corresponding reduction of the energy in the primary circuit to substantially zero value as indicated by the diagrams, in which case the maximum [fol. 793] of efficiency is attained in the transformation of energy from the primary to the secondary circuit."

I have previously stated that Seibt and others in conceiving the quenched gap system had their attention attracted by this first beat or period of minimum current in the primary circuit brought about by coupling two circuits closely, and in the quotation above, Seibt not only lays stress upon employing the first beat to obtain the quenching action, but brings out that it is desirable to secure this first beat as early as possible by tight coupling, and further examination of my sketch O will make clear how tight coupling may be utilized to produce an early beat. In Figure 6*b* of sketch O, I have shown on enlarge scale the oscillations in the primary circuit illustrated in Figure 6. In Figure 6*d*, it is seen that the green oscillations are slower than the red oscillations. I have shown by mathematical formula and explained how difference between the two frequencies depends upon the tightness of coupling—the tighter the coupling the greater the difference. In Figure 6*d*, it will be seen that the two oscillations start together, or at the same instant, but gradually draw apart or out of phase until the faster one becomes opposed to the slower one. Now it is apparent that the greater the difference in frequency between these two oscillations the sooner will the faster one reach the point at which it can oppose the slower one, and result in a beat or point of minimum or no current. In other words, the tighter the coupling, the sooner the beat will be reached. The value of an early beat is—first, to prevent the energy from unnecessarily long operating at two frequencies, for the shorter the time it so operates, the weaker will be the resulting radiated signal at these two frequencies; second, to prevent the energy from remaining long in the primary circuit where the ex-

penditure of energy in the spark gap is large; and, third, to separate the two coupling frequencies as far as possible to avoid interference.

There is also another way besides that of coupling of controlling the time at which the first beat is secured and which way is also utilized to secure the perfection of the beat; by perfection, I mean obtaining practically no current flow at this point by balancing the intensity of the opposed oscillations. This second way is through adjustment of the time periods of the two circuits, through either adjusting capacity, or inductance, or both. I have, in my analogy of electrical circuits to oscillating pendulums, pointed out that if two pendulums of different sizes are coupled together, as through a rubber band, they will transfer energy of oscillations back and forth from one to the other, but that it will take a long time for the smaller pendulum to get all of the energy of the larger pendulum and vice versa, so that production of beats or periods of no energy in the one and the other pendulum will be irregular. The same thing happens in coupling electrical circuits of different frequencies, so that in quenched gap systems, the time periods of the two circuits are adjusted approximately in accord to avoid irregular production of beats or to give better control over the point of production of the first beat. This adjustment has nothing whatever to do with the resonant transfer of energy between two circuits in a quenched gap system which is so vital to the open gap system. During the short interval of energy transfer in the quenched gap system, oscillations are taking place at [fol. 794] two widely different frequencies, both widely different from the natural period of the two circuits, and resonance, or resonant transfer of energy, does not feature. The time period adjustment is entirely for the purpose of controlling the production of the beat. In the open gap system, the energy is slowly transferred at one frequency from the primary to the secondary circuit, and resonance is vital and necessary to secure an efficient transfer of energy as well as to avoid having two frequencies in the radiating circuit, one a forced oscillation, and the other an oscillation at the natural period of the radiating circuit, which I have illustrated in Figure 4a of my sketch H, where the two circuits are not in resonance, as compared to the

correct way illustrated in Figure 5a of the same sketch, where the two circuits are in resonance.

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It is therefore apparent in the quenched gap system that if the time periods of the two circuits are widely different, the production of beats will be irregular and more difficult to predict and to control. The transfer of energy to the circuit having large capacity for absorbing energy will be quick, while the transfer of energy to the circuit having small capacity for absorbing energy will be slow. Therefore, by adjusting the two circuits practically the same in time period, one variable element in proper adjustment of the system is eliminated.

In fact, however, the two circuits of a quenched gap system are not in practice adjusted to have the same time period, another feature in adjustment of quenched gap systems making it desirable to affect a compromise in this respect, and this feature is the production of a perfect or nearly perfect beat. In my sketch O, Figure 6d is an enlargement of Figure 6, which illustrates the two oscillatory currents in the primary of a quenched gap system. I have pointed out that in order to secure a nearly perfect beat or period of no current in the spark gap, the two currents when they draw apart at the beat should be of practically the same value in order that one may cancel the other at this point of being in opposite phase to reduce the current to practically zero. If the two circuits are in precise adjustment in the matter of time periods being the same, the current of the higher frequency is found to be the stronger, and the current of the low frequency, the weaker. I have illustrated this by showing the red current at the point *x* extending above the line somewhat more than the green current at the point *y* extends below the line. The smaller green current would only neutralize a part of the larger red current, leaving a residual current flowing through the gap at the beat in a precise adjustment of the time periods of the two circuits. For this reason it is the practice in quenched gap systems to throw the two circuits somewhat out of adjustment in order to bring the two currents to practically the same value at the beat and obtain a resultant no-current effect. The result is that a properly calibrated or adjusted quenched gap system has the two [fol. 795] circuits out of adjustment in the matter of time

periods, while at the same time a properly adjusted open gap system has the two circuits in very precise adjustment to have the same time period. This out-of-adjustment condition of the quenched gap system is most apparent from analyzing the steps taken by an operator to calibrate such a system. In such a calibration, the operator will first carefully adjust the primary circuit to a definite frequency, using a wave meter which is an instrument for measuring frequency, being certain that the secondary or antenna circuit is open so as not to influence his measurement. He will then open the primary and adjust the secondary to the same frequency. Having so adjusted the two circuits, he then starts his set in operation, and listening to the note given off by the transmitter, will gradually throw the two circuits out of tune until a nice clear note is had, which indicates to the operator that this out of tune adjustment has been carried to a point where the two oscillations are practically neutralizing each other at the beat and good quenching is had; that is, that the spark gap is opening up and not reclosing to permit a retransfer of energy to the primary circuit.

Therefore, the adjustability of the circuits of a quenched gap system are first, for control over the point or instant of securing a beat, and second, for throwing the two circuits out of tune sufficiently to produce a perfect beat, and these purposes have nothing to do with a resonant transfer of energy between the two circuits, for the very idea of producing beats requires the production of two frequencies to which there can be no resonance.

In a quenched gap system, it is not only necessary to produce a perfect beat, but a spark gap must be used having such characteristics as to permit of employing this beat usefully. I have discussed somewhat at length the production of ionization in the space separating the two electrodes of a spark gap, and how it is this ionization that is responsible for current flow in the space, and have pointed out that if the gap structure is of such a nature as to allow some ions and electrons to remain in the space, after the main current has stopped flowing, it is easy for the new current to start in the opposite direction, and how vital this maintenance of ionization in the gap space is to the open gap system, where it is essential that the oscillations in the primary circuit persist for a long time. In the quenched gap system, there is required a gap having characteristics

just the reverse of the open gap. The ionization must quickly disperse, that is, during the first beat, so that when the secondary circuit which has received all of the energy tries to return some of the primary circuit, it will encounter the extreme high resistance of a completely de-ionized gap and cannot return. This essential characteristic of the quenched gap is obtained by very definite structure and choice of materials opposed to the open gap structure. I have pointed out that one of the requirements for an open gap to aid in persistent oscillations is high temperature, this high temperature being utilized to vaporize the metal of the electrode to fill the space with metallic ions which move slowly and can not be dispersed so easily, and also that high temperature causes the electrodes to emit electrons into the space, which action may be going on while the current is zero at a reversal, making available some electrons in the space when the current is ready to commence flowing in the new direction. At page 165, Mr. Waterman [fol. 796] quotes from plaintiff's Exhibit No. 60, Navy Contract No. 132, one of the requirements for the Wireless Specialty Apparatus type in plaintiff's Exhibit No. 87, as follows:

"Quenched spark gap, new design, perfect cooling by special central draft. (We reserve right to furnish our new type tumblar gap.) This latter having new feature of cooling and perfect sparking alignment with ease of dismantling."

Thus the gap was to be of the "quenched type," and particular emphasis was laid on cooling, one of the essentials for quick quenching as opposed to persistency. The designation of the gap as "quenched" type also bring out that it had many other characteristics well known to those skilled in the art for securing quenching. I am familiar with many designs of quenched gaps which have been put into practical use, and all of them embody the following features looking toward quick quenching:

(1) Arrangements for good cooling through choice of materials having high thermal conductivity, provision of large cooling surface, and use of water cooling or air-blasts in high power installation.

(2) Choice of materials for electrodes or sparking surfaces which do not easily vaporize or oxidize, such as electrolytic silver, and electrolytic copper.

(3) Use of a number of very small gap spaces in series; that is, instead of having one gap say of one-half inch total length, to divide this over a plurality of gaps such as 10 to 15.

(4) Using sparking surfaces of very large extent, such as flat discs, two to three inches in diameter, instead of spark balls or cylindrically shaped electrodes of about one-half inch in diameter.

(5) Inclosing the sparking space in an air-tight arrangement to prevent oxidization of the sparking surfaces from further supply of air after the small amount which is entrapped in the air-tight space on closing is consumed, and to maintain the space under partial vacuum.

(6) Avoiding the admission to the gap space of gases having high atomic weight with resulting slow moving ions.

The good cooling on (1) prevents vaporizing the metal of the electrodes, thus keeping the gap space clear of metallic vapors of high atomic weight, which would create ions which move too slowly to disperse in the gap space before the new current starts, and also keeps the temperature of the electrodes sufficiently low to prevent the emission of electrons set into motion by heat.

The choice of materials of the electrodes of (2) cooperates with the low temperature to prevent vaporization, and through not oxidizing, does not create a new substance which will vaporize, and being a material of good thermal conductivity cooperates in obtaining good cooling. The lack of oxidation maintains the good thermal conductivity characteristics of the metal.

The dividing of the total gap length into a number of short gap spaces of (3) gives the electrons and ions in each of the short spaces a very short distance to travel to get to an electrode during the short period of no current, over the travel required of the electrons and ions left in a long gap space.

The use of sparking surfaces of very large extent of (4) gives the electrons and ions in the spaces easy access to the electrodes, not being compelled to crowd to areas of small extent.

[fol. 797] The inclosing of the sparking space of (5) aids in preventing oxidation, which would be had with a free access of air to the sparking surfaces, and if such oxidation is had, it results in reducing the thermal conductivity to

destroy good cooling, as well as creating a vaporizing material on the surface of the electrode. The inclosing also allows the creation of a partial vacuum, and where a partial vacuum exists, fewer collisions can take place between electrons and atoms forming the gas in the space, and under such conditions, the ionization dispersion is always more rapid.

The avoiding of the admission to the gap space of gases having high atomic weight of (6) provides for the use of rapidly moving ions which can disperse in a short interval of no current.

These are all features which would militate against securing the persistency of oscillations in the primary circuit of the open gap type, as such features tend to cause the gap to open or quench long before the primary circuit has delivered a material part of its energy to the slowly fed radiating circuit, thereby preventing the primary circuit from being a reservoir of energy for the dependent radiating circuit. Such a gap structure would also have a high resistance, resulting in large energy losses in the primary circuit, if the energy endeavored to flow or persist for a long time, and would thereby militate against the primary circuit being a good conserver of energy, which is essential to the open gap system. This high loss feature is not important in the quench gap system, because the system is based upon the principal of getting the energy out of the primary circuit as early as possible into a circuit that has no spark gap, and whose only loss aside from useful radiation is the small resistance of a wire that can be made very small by proper choice of size and material of wire.

Summarizing, the quenched gap transmitter of the Wireless Specialty Apparatus type illustrated in plaintiff's Exhibit 87, is entirely different from the open gap type of transmitter of the Marconi patent 763772, because (1) it is based upon the principle of quickly dumping the energy of the primary circuit into the radiating circuit, where the frequency of the system is then determined by the period of the radiating circuit in its electrically disconnected relation to the primary circuit as disclosed by Lodge in his patent in suit prior to the Marconi application, as compared to the principle of the open gap system in which the energy is maintained for a long time in the primary circuit as oscillations of the desired frequency for the entire system as determined by the natural period of the primary circuit, and

which energy is slowly and resonantly fed to a radiating circuit at the rate at which it can be radiated; (2) because there is no resonant transfer of energy between the primary and secondary circuits of the quenched gap system, the energy going over at two widely separated frequencies, neither of which is of the desired frequency and neither of which has the frequency of either the primary or secondary circuit, as compared with the open gap system where the energy is transferred at one frequency, which is the frequency of the primary circuit and the frequency of the secondary circuit precisely tuned to the primary circuit; (3) because the arrangements for the adjustments of the two circuits of the two systems are for entirely different purposes, in the quenched gap system, the adjustment being for the purpose of controlling the point of production of a beat of no energy in the primary circuit, which beat is [fol. 798] entirely foreign to the principle of the open gap system, and for throwing the two circuits somewhat out of adjustment to control the perfection of the beat, while in the open gap system, the purpose of the adjustment of the constants is to obtain a precise resonant transfer of energy from one circuit to another in no way forming a feature of the quenched gap system; (4) because the quenched gap system depends upon a tight coupling or close relation of the two circuits that will produce two frequencies sufficiently widely separated to obtain an early beat while the open gap system depends upon a coupling relation between the two circuits so loose that for all practical purposes, the two frequencies will be merged into one; and (5) because when used with a two-circuit receiver the quenched gap transmitter results in a three-circuit tuned system, the frequency of the oscillations being determined by the radiating circuit with the primary circuit entirely out of action, while the open gap system is a four-circuit tuned system, the frequency of the oscillations being determined by the primary circuit at the transmitter, which is in action during practically the entire time of radiation.

(Defendant's counsel offers in evidence the following exhibits referred to by the witness:)

F-2. The London Electrician for September 14, 1888, pages 587-589; September 21, 1888, pages 625-627; September 28, 1888, pages 663-665; October 5, 1888, pages 697-698; October 12, 1888, pages 725-726; October 19, 1888, pages

757-758; October 26, 1888, pages 788-789; November 9, 1888, pages 16-18; November 16, 1888, pages 41-44.

G-2. Lightning Conductors and Lightning Guards, by Lodge, published at London, England, 1892, pages 352-354.

H-2. Modern Views of Electricity, by Lodge, published at London, England, 1889, page 373.

I-2. Transactions of American Therapeutic Association, New York, 1894, article on D'Arsonval modification of current of great frequency.

J-2. Instructions for Use of Wireless Telegraph Apparatus, by Hudgins, published at Government Printing Office, Washington, D. C., 1903.

K-2. Gesellschaft fur drahtlose Telegraphie, published at Berlin, 1904.

L-2. Certified copy of drawings from Navy Department.

M-2. Loftin sketch F.

N-2. Wireless Telegraphy, by Zenneck, New York, 1915.

O-2. Loftin sketch G.

P-2. Loftin sketch H.

Q-2. Loftin sketch I.

R-2. Loftin sketch K.

S-2. Hutin Leblanc patent 838545, December 18, 1906.

T-2. Pupin patent 519347, May 8, 1894.

U-2. Pupin patent 640516, January 2, 1900.

V-2. Loftin sketch L.

W-2. Loftin sketch M.

X-2. Telsa patent 645576, March 20, 1900.

Y-2. British Telsa patent 20981 of 1896.

Z-2. British Braun patent 1862 of 1899.

A-3. British patent, Braun 12420 of 1899.

[fol. 799] B-3. Loftin sketch N.

C-3. Seibt patent 1216615, February 20, 1914.

D-3. Loftin sketch O.

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Answer to question 29 continued. So far I have discussed the transmitter only of the complete system illustrated in plaintiff's Exhibit No. 87, Wireless Specialty Apparatus type. The system illustrated includes both a transmitting station and a receiving station, the receiving station having two circuits comprising an open or elevated-conductor circuit coupled to a secondary closed circuit. The complete system illustrated is a three-circuit system, instead of a four-circuit system as described in the Marconi patent

for, as I have explained, the primary circuit at the transmitting station of the Wireless Specialty Apparatus quenched-gap type only functions to quickly deliver a large quantity of energy to the radiating system at two frequencies not featuring in the operation of the system as a whole, and then goes out of action while the rest of the system is in action, as compared with the function of the primary circuit at the transmitting station of the Marconi open-gap type in which the primary circuit remains in action during the entire period of action of the other three circuits, the primary circuit during all this time acting as a reservoir of energy, determining the frequency of oscillation of the entire system, and slowly feeding the energy to the radiating circuit, a dependent stepping-stone in the system. The Marconi open-gap system requires the precise adjustment of the time periods of all four of the circuits to be the same, because all four are in action at the same time and for a long time. In the Wireless Specialty Apparatus quenched-gap type, there is required for good selectivity a precise adjustment of the time periods of but three circuits; namely, the open radiating circuit at the transmitter and the two circuits at the receiver. It is immaterial to the circuits of the receiver what the time period of the primary circuit at the transmitting station is, for this primary circuit has no frequency in common with the receiving station, and also it is entirely out of action when the receiving station is in action. In this respect the Wireless Specialty Apparatus quenched-gap type is similar to the Lodge type prior to Marconi, for Lodge determined the frequency of his system in the secondary or radiating circuit and employed two circuits at the receiving station, one of which was definitely tuned to the frequency of the radiating circuit at the transmitting station, while the secondary circuit of Lodge is impliedly tuned by Lodge, and definitely tuned by Marconi immediately after Lodge in his 1899 patent.

30. Question. Compare the three groups of claims of the Marconi patent 763772 with the Wireless Specialty type of apparatus and say whether, in your opinion, the language of said claims is or is not as applicable to said Wireless Specialty Apparatus as to the prior art which you have discussed.

[fol. 800] Answer. Considering first the group of claims relating to the transmitting station, I have previously

pointed out that this group of claims contains very definite language to the effect that the primary circuit at the transmitting station unqualifiedly has the duty of determining the frequency of the oscillations for the entire system, this language, in referring to the apparatus in the primary circuit, being generally stated as follows: "A means which automatically causes oscillations of the desired frequency." In the Wireless Specialty Apparatus quenched-gap type, plaintiff's Exhibit 87, there is not included at the transmitting station any provision for the primary circuit automatically or otherwise causing oscillations of the desired frequency. The two circuits at the transmitter are tightly coupled to produce oscillations of two undesired frequencies, as far as the system is concerned, for a purpose foreign to the purpose of the open-gap system, and it is my opinion that the language of these claims makes them not applicable to the Wireless Specialty Apparatus quenched-gap type, for if applicable to the quenched-gap type, it would be applicable to the Lodge type. In my opinion, the language is applicable to the type shown in the Tesla patent I have discussed and beyond all doubt applicable to the Stone patent and the Stone to Baker letters.

The transmitting claims further include means or instrumentalities for tuning or adjusting the two circuits at the transmitter to resonance or accord, in general, about as follows: "Means for adjusting the oscillation period of each of the two circuits connected with the transformer to bring them into accord with each other." In the Wireless Specialty Apparatus type, there are included variable inductances and capacities which were found in the art prior to Marconi and are found in the Marconi patent 763772, but these variable elements are not for the purpose of adjusting the two circuits in the quenched-gap type to resonance or accord, but are for the purpose of permitting an adjustment or control of the point of securing a beat, and for throwing the two circuits out of a precise adjustment to the same time period to secure a perfect beat. These variable elements were found in Lodge in the way of a variable inductance coil, in Tesla in the way of variable capacity or inductance, in the Marconi 1899 patent in the way of variable inductance and variable capacity, and in the Stone patent and Stone to Baker letters as variable inductance specifically, and impliedly variable capacity, these all being shown in the radio art prior to Marconi. These vari-

able elements were also found in numerous publications referring to electricity in general and high frequency electrical currents on wires. Marconi took them for his open-gap system for use in a particular way, that of precisely adjusting the circuits so that oscillations generated in one at the desired frequency could be resonantly transferred to another circuit, but in my opinion, this was used in the old Tesla patent I have referred to and in the Stone patent and Stone to Baker letters at a transmitting station. The quenched-gap Wireless Specialty Apparatus Type system took the same old instrumentalities and used them for an entirely different purpose, that of controlling the point of production of beats and securing a perfect beat, and it is my opinion that there is nothing in common between the two uses that was not already known to the art.

[fol. 801] Receiving station claims: In this group of claims, two or them, namely, Nos. 2 and 13, do not in any way refer to the matter of resonance between the two circuits of the receiving station, and I have previously pointed out that their recitation of simple combinations of electrical elements makes them easily found in numerous showings of the prior art, such as Lodge's Figures 12 and 13 illustrating his receiving station, in Figure 1 of the Marconi 1899 patent, and in the Stone patent and Stone to Baker letters, and in my opinion, these claims are just as applicable to the simple prior art as to the Wireless Specialty Apparatus type of receiver, plaintiff's Exhibit No. 87.

The rest of the claims of the group all include means or instrumentalities for adjusting the two circuits to resonance, the means being included in either one of the circuits, or in both. The means illustrated in the Marconi patent figures and described in the Marconi specification simply amount to variable inductances and variable capacities found in the art prior to Marconi, as for example, the variable coil of Lodge, the variable inductance and variable capacity of the Marconi 1899 patent, the variable inductance and variable capacity of the Tesla patent, and the variable inductance specifically mentioned by Stone, and the variable capacity impliedly included by Stone, all being in the radio art. I have also referred from time to time to other art concerning the use of these variable elements, in the general application of electricity as well as high-frequency oscillations in connection with wire work. The Tesla patent, the Marconi

1899 patents, and the Stone patent and Stone to Baker letters cover the use of these variable elements for tuning two circuits in a radio system to resonance, all of them having specifically shown receiving stations so tuned except Tesla. In my opinion, the receiving station claims of the Marconi patent in suit are just as applicable to the prior art as they are to the receiving station of the Wireless Specialty Apparatus type.

Claims covering both stations: The first claim of the two in this group, claim 10, broadly claims having four circuits of the system in resonance. In my opinion, this claim is not applicable to the Wireless Specialty Apparatus type, because the operation of the quenched-gap transmitter results in having but one circuit available for tuning with the two circuits of the receiving station, resulting in a system having but three circuits in resonance. The claim is in my opinion applicable to the prior art, as for instance, the Tesla transmitter having two tuned circuits taken in connection with the Marconi 1899 receiver having two tuned circuits, or, to the Stone four-circuit tuned system shown in his patent and the Stone to Baker letters.

The other claim of the group is restricted to means or instrumentalities for adjusting the four circuits to resonance, and these means or instrumentalities merely amount to variable inductances and capacity shown in the prior art discussed in connection with both the transmitting group and receiving group. In my opinion, this claim is not applicable to the Wireless Specialty Apparatus type because at the transmitting station the adjusting means are not for the purpose of tuning the two circuits to resonance, but for the purpose of securing control over beat production, as well as best perfection, which operation in no way involves resonance but is, in fact, opposed to it. It is my opinion that this claim is applicable to the prior art, as for instance, the two-tuned circuit transmitter of Tesla taken in [fol. 802] connection with the two-tuned circuit receiver of the Marconi 1899 patent, as these showings include variable elements for adjustment, or as shown as a complete system by Stone in his patent or in his Stone to Baker letters, Stone having employed variable or adjustable elements for tuning to resonance.

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Before leaving the discussion of the Wireless Specialty Apparatus quenched-gap type, plaintiff's Exhibit No. 87, I desire to point out that the bid of the Wireless Specialty Apparatus Co. to furnish this type was based on Navy Wireless Specification No. 16-T-5, plaintiff's Exhibit No. 37, these specifications bearing date of 1910. This date was before quenched-spark apparatus became available, and the specifications do not require quenched-gap type of apparatus. The contract placed by the Navy with the Wireless Specialty Apparatus Co. for the quenched-gap type, plaintiff's Exhibit No. 60, contract No. 133, is dated in the year 1913, at which time quenched-gap apparatus was well known and available, and the contract provided for this new type. On page 5, paragraph 12, (a) of the specifications 16-T-5, under the heading "Oscillation transformer and antenna helix," there is found the following language quoted by Mr. Waterman at page 168 of his deposition:

"(a) The oscillation transformer shall consist of two inductively coupled coils with means for variation of coupling over a wide range. This range should include an indicator and easily made adjustment for close coupling. The contract shall state the recommended normal degree of coupling, and this shall be such as will give only one frequency in the antenna, the change of coupling to be made preferably by mechanical movement of one coil with relation to the other."

Appreciating that these specifications were written in the day of the open-gap type of transmitter, when the quenched-gap type was not yet available, the meaning of the above quotation becomes perfectly clear. It first requires means for variation of coupling over a wide range, this in order to secure very loose coupling for normal operation when selectivity due to having but one frequency was desired, and at the same time be able to secure a close coupling for emergency purposes. It has long been the instructions to operators that in an emergency, when it was desired to attract the attention of stations who might be listening on other wave lengths or frequencies, to employ a tight coupling in order to broaden their tune to cover a wide range of frequencies. Distress calls by ships, commonly known as "S. O. S. calls," are always made with a tight coupling in

order that the ship may have a better chance of attracting the attention of other ships.

The quotation then refers to a "normal degree of coupling," and states that it shall be such as will give "only one frequency in the antenna." Thus, for normal operation, it was required in the old specifications, that the degree of coupling should be sufficiently loose to permit of there being a transfer of energy between the two circuits at but one [fol. 803] frequency. The quotation in no way intends to imply that the old type of open-gap transmitter under consideration when the specification was drawn, was to be normally operated with a close coupling. When it was operated with close couplings, the use was abnormal and deliberately intended to destroy the selectivity which was one of the objects of the Marconi specification.

I also wish to point out that plaintiff's witness Langley, in plaintiff's Exhibit 87, has marked the condenser in shunt to the telephone R at the receiving station as j^a , which is the same designation given to the condenser between the two parts of the coil j^2 in Fig. 2 of the Marconi patent, and is the same as was done by Mr. Waterman in his sketch No. 3, "Marconi Simplified Receiving Circuit," to which I have previously taken exception, as the action of the condenser j^3 inserted between the two halves of the coil j^2 in the Marconi Patent is entirely different from that of the condenser j^a in plaintiff's Exhibit 87, Waterman Sketch No. 3. This difference I have discussed more at length beginning page 680 of the typewritten record of my deposition.

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31. Question. Mr. Waterman, at page 171 of his deposition, makes reference to the Navy Manual of 1915 and the Signal Corps book Radiotelegraphy as supporting his contention that the circuits of the Wireless Specialty type of apparatus are in resonance. Do you agree with Mr. Waterman's conclusion?

Answer. Mr. Waterman's quotation from the Navy Manual of 1915, plaintiff's Exhibit No. 78, page 57, is as follows:

"89. In Figure 29a, A B and C D have been given some turns in common, forming an air core-auto-transformer, but, whether directly or inductively connected these two circuits—the close and open circuits—must have equal natural

periods in order to produce and radiate electric waves efficiently."

Examination of Figure 29a referred to in the quotation shows that the quotation itself was concerned with the open-gap type of transmitter instead of a quenched-gap Wireless Specialty Apparatus type, both because the figure conventionally illustrates an open gap and also because the figure is entitled "Slaby Arco", which was a commercial type of open-gap apparatus that went out of existence before the quenched-gap type came into use. The quotation very correctly describes the tuning between the primary and secondary circuits of the open-gap type to which it refers, but forms no basis for contending that because the Slaby Arco open-gap type had resonance between the two circuits that the Wireless Specialty Apparatus quenched-gap type also had such resonance.

Mr. Waterman also quotes from page 163 of the same publication as follows:

"This includes calibration and tuning. A station is tuned when both sending and receiving circuits are correctly calibrated, coupled and adjusted to the standard damping and standard wave lengths."

This is a very general statement as to the desirability of having the transmitting and receiving stations of a system [fol. 804] in tune, and adjusted to be in tune at the standard wave lengths. There is nothing in this quotation from which to draw conclusions as to the difference between the open-gap type of transmitter and the quenched-gap type. The statement applies just as well to a system having but one circuit at each station as to a system having two circuits at each station. In my opinion it is in no way a basis for Mr. Waterman's contention that the two circuits of the Wireless Specialty Apparatus quenched-gap type are in resonance.

Mr. Waterman further quotes from the same page of the same publication as follows:

"The closed sending circuit should be in resonance with the open circuit and the coupling and decrement of the open circuit such as to afford the necessary selectivity to the receiving circuits with the best efficiency of radiation."

This is also a very general statement in no way disclosing whether the type of apparatus referred to is the quenched-gap type or the open-gap type, and furthermore, is a very loose and indefinite technical statement. It in fact reads that the closed sending circuit is not only in resonance with the open circuit, but is in resonance with "the coupling and decrement of the open circuit." Such a statement has no technical meaning, as there is no such thing as resonance between a circuit and a coupling, or between a circuit and damping. In my opinion the statement has no technical value in drawing a conclusion as to the operation of the two different types of systems under consideration. The writer of the quotation evidently had in mind the open-gap type of circuit with loose couplings as will be apparent from an analysis of a statement in the paragraph immediately following, also quoted by Mr. Waterman:

"Receiving circuits to receive from such a sender should be in resonance with each other and with the sending circuits and should have the same coupling as the sending circuits. The telephone diaphragm should be in resonance with the wave train (alternator) frequency and with the operator's ear."

This is also a very loose technical statement. In no system is it necessary for the receiving circuits to be in accord with the circuits at the transmitting station as far as time periods of the circuits themselves are concerned. The receiving station circuits are not concerned with the time periods of the transmitting circuits, but only with the frequency of the energy-bearing waves that emanate from the transmitting circuit. For instance, a generator of a definite frequency can impress oscillations upon a radiating circuit which has a natural time period entirely different from the frequency of the oscillations being impressed upon it, and this radiator will radiate energy waves at the frequency impressed. Under such circumstances it would be absurd to try to adjust the time periods of the receiving circuits to the time period of the detuned radiating circuits. The point I make is that the receiver is not concerned with whether the frequency of the system originates in the primary circuit as it does in the case of the open gap type, or originates in the radiating circuit as it does in the quenched-gap type, as long as there is one definite frequency and the oscillations

are sufficiently long drawn out to employ resonance. Therefore, in my opinion, there is nothing in the quotation on which to found the contention that the Wireless Specialty [fol. 805] Apparatus quenched-gap type employs resonance in the same way as the Marconi open-gap type.

The quotation is important, because it shows that the previous quotation as to the sending circuit refers to the open-gap type, rather than the quenched-gap type, for it states that the receiving circuits, to be in resonance, should have the same coupling as the sending circuits. Now, for the receiving circuits to be in resonance, they must have loose couplings between them to avoid transferring energy at two frequencies, and if the sending circuits are to have this same loose coupling, the open-gap type of circuit is implied.

Mr. Waterman quotes from the Signal Corps book, Radiotelegraphy, plaintiff's Exhibit No. 91, page 57n, as follows:

"When the adjustments of a quenched spark transmitter have been correctly made—that is, the circuits are in resonance, the coupling is right, etc.—a simple experiment will show that the primary current is a minimum; that is, the spark has been quenched and the primary current has been stopped quickly, as at the point Q of Figure 53, and that at the same time the secondary current is a maximum; that is, it persists for a long time, as shown in Figure 56."

This quotation definitely refers to the quenched-gap type, and specifically brings out that the adjustment for proper quenching to quickly stop the flow of energy in the form of oscillations in the primary circuit and thus to leave the action to the radiating circuit, depends upon proper coupling as well as upon a condition very loosely and incorrectly termed in the quotation as "resonance" between the primary and secondary circuits. It is a great failing among workers in the art to speak of "resonance" under all circumstances of two circuits having the same natural periods, irrespective of couplings between the circuits. Correctly used, resonance means responding at the frequency of the action from which the responder drives its response creating energy. In the tightly coupled two circuits of the quenched-gap type of transmitter, while the two circuits may have their time periods adjusted to be approximately but not precisely the same, there is no resonant effect between them

as the energy oscillates in the two circuits at frequencies entirely different from the frequencies that would result from resonant response if the two circuits were loosely coupled.

The quotation clearly brings out that the current in the primary circuit is of very short duration, being stopped quickly, and that it is the current in the radiating circuit that persists for a long time. In a discussion of the Lodge patent, Mr. Waterman and I agreed that persistency of oscillations is necessary for resonance, and there is no basis for his contention that this quotation which clearly brings out a lack of persistency in oscillations in the primary circuit supports his contention that the Wireless Specialty Apparatus quenched-gap type actually employs resonance as between the two circuits.

I am therefore of the opinion that Mr. Waterman's contention finds no support in the Navy Manual of 1915 or the Signal Corps book Radiotelegraphy.

32. Question. Please make the same comparison with respect to the other types of apparatus used by defendant and referred to by Mr. Waterman.

Answer. I have examined the exhibits and the testimony of the various witnesses describing the other types of apparatus referred to by Mr. Waterman as coming within the terms of the Marconi patent 763772, and find that the following types in all practical aspects correspond to the Wireless Specialty Apparatus Co. quenched-gap type which I have just discussed.

Kilbourne & Clark type, plaintiff's Exhibit No. 95, based on Navy Specification 16-R-1.

Navy type, described by witness Weagant, plaintiff's Exhibit 93.

Wireless improvement type, plaintiff's Exhibit 88.

Simon type, plaintiff's Exhibit 89.

National Electrical Supply Co. type, field radio pack set, plaintiff's Exhibit 80.

Atlantic Communication Co. type (no exhibit).

Garwood Electric Co. type (no exhibit).

Radio Telephone & Telegraph Co. type (no exhibit).

Signal Corps pack set, 1915 type (no exhibit).

Tractor sets (no exhibit).

Navy Specification No. 16-R-1a (no exhibit).

Portable wireless set (plaintiff's exhibit 41).

United States Signal Corps Specification, radio field wagon set, plaintiff's Exhibit No. 44.

In some of the above types I find that at the receiving station the secondary circuit is of the type known as "untuned." That is, there is no provision made for varying the time period of the secondary of the receiving circuit to correspond to the frequency of the incoming signal, the receiver depending upon tuning the primary or open circuit only. Of the above types the following have untuned secondary circuits at the receiver.

Atlantic Communication Co. type.

Signal Corps pack set, 1915 type.

The exhibits and testimony of plaintiff's witnesses make it clear beyond all doubt that the transmitting stations of all of the above types have quenched-gaps, and are therefore subject to the same differentiations over the open gap type of the Marconi patent that I have brought out in connection with the Wireless Specialty Apparatus quenched-gap type, as for instance (1) no resonant transfer of energy between the primary and secondary circuits; (2) no means for adjusting the two circuits to resonance, the adjustment means in the quenched-gap system being for controlling the point of beat production and for throwing the two circuits somewhat out of time period adjustment to obtain a perfect beat; (3) no provision for causing the primary circuit to "automatically produce oscillations of the desired frequency," and (4) the inclusion in the quench-gap type of specific means, a quenching gap, to prevent the primary circuit from being a persistent oscillator, a reservoir for the radiating circuit, and a good conserver of energy in the primary circuit.

In all of the above types, like the Wireless Specialty Apparatus type, the radiating circuit at the transmitter determines the frequency of the oscillations and is the place where the oscillations persist or are maintained for a long time, and it is this circuit therefore to which the receiving station absorbing circuit is tuned, if there is but one tunable circuit at the receiving station, and to which the two circuits are tuned, if there are two tunable circuits at the receiving station. Therefore, these types are either two- [fol. 807] tuned circuit systems, or three-tuned circuit systems, and not the four-circuit tuned system of the Marconi patent.

I have also named two types in the above group which have a secondary circuit at the receiving station which is not tunable. That is, the secondary circuit is designed to remain fixed in frequency or natural time period to be used with a primary or absorbing circuit which is tunable through a wide range of natural time periods. This of course makes these receivers different from the idea of tuning the two circuits to the same time period which runs through the Marconi specification and claims. They merely amount to the receiver shown in Figure 13 of the Lodge 1898 patent in suit.

I note that Mr. Waterman at page 182 of his deposition, in referring to one of the Telefunken types of receivers which has an untunable secondary comments as follows:

"It differs from that of Marconi's Fig. 2 and of the Telefunken E₃ receiver only in the omission of condenser k' . This means merely that capacity enough is provided for in the coil itself, the coil referred to being the coil j^2 of the oscillation transformer."

Following such line of argument the secondary circuit of the Lodge receiver, Figure 13, is a tunable circuit if this is what Mr. Waterman means to imply. The Lodge secondary winding u inherently has distributed capacity as does the coil j^2 of the Marconi Figure 2.

In the group above, the Signal Corps pack set, 1915 type, has a type of receiver far removed from that shown in the Marconi patent, this type being illustrated in plaintiff's Exhibit 91. This receiver has no oscillation transformer between the primary and secondary circuits. Two small capacities marked in plaintiff's Exhibit 91 as "fixed coupling condensers" entirely displace the two winding oscillation transformer of the Marconi Figure 2. This type of coupling entirely removes the receiver from the language of the receiver claims of the Marconi patent, all of the claims being based upon an oscillation transformer. In the "long-wave" type illustrated in plaintiff's Exhibit 91, the secondary circuit is in no wise tunable, and in addition to being outside the Marconi patent on account of the type of coupling, is also lacking in the tuning of the secondary circuit in the Marconi specification and claims.

Therefore, all I have said as to the dissimilarity of the Wireless Specialty Apparatus Co. quenched-gap type, and

the Marconi open-gap type applies to the above group of types with the addition that the above group of types includes receivers which are, in my opinion, entirely outside of the showing in the Marconi patent.

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The following group of types are like the Wireless Specialty Apparatus type in respect to having quenching gaps and the necessary circuit relation for quenched-gap action, and therefore are different from the Marconi open-gap type for the same reason as I have set forth for the Wireless Specialty Apparatus Co. quenched-gap type. But [fol. 808] the apparatus of this group also differs from the open-gap type of the Marconi patent for a reason which I will set forth after I list these types as follows:

Telefunken type (plaintiff's Exhibit No. 79).

Lowenstein type (plaintiff's Exhibit No. 101).

Army pack sets (testimony of plaintiff's witness, Weagant).

Telefunken field wagon apparatus (plaintiff's Exhibit No. 90, pages 91-101).

Foote-Pierson pack set (plaintiff's Exhibit 102).

Signal Corps pack set, 1913 Model (plaintiff's Exhibit No. 92).

North American Wireless Co. type (plaintiff's Exhibit No. 42).

All of the transmitters of this group of types do not have the two-winding oscillation transformer linking the primary and secondary circuits illustrated, described, and claimed in the Marconi patent, except the testimony of plaintiff's witnesses admits that plaintiff does not know whether the North American Wireless Co. type has or has not the two-winding oscillation transformer. Plaintiff's witnesses in the text of their testimony with respect to this group have admitted that there is but one winding to which both circuits are directly connected, but in their diagrammatic sketches, plaintiff's Exhibits 7, 9, 101, and 102, have illustrated two windings, one in black and one in red, drawn in close relation. These illustrated two windings in the exhibits are therefore not in accord with the testimony of the witnesses and the descriptive matter in plaintiff's exhibits describing these types.

The claims of the Marconi patent refer to two windings in the oscillation transformer interlinking the two circuits,

one winding being in circuit and one winding being in the other circuit. In the Marconi open-gap type there is particular reason for employing a two-winding transformer, for I have explained that the Marconi system depends upon getting a very loose coupling between the two circuits, and since a two-winding transformer permits of specially separating the two windings to give any desired degree of loose coupling. In the quenched-gap type, where a tight coupling is vital to the operation, no particular benefit results in having two windings from a point of view of coupling. In those types of quenched-gap sets having two windings, the arrangement is adopted simply for the purpose of permitting ease of adjustment in calibrating the apparatus for use. In the direct-coupled type the only way coupling can be adjusted is by changing the number of turns in the one winding to which the two circuits are directly connected. Each circuit may have means for independent connection to the winding, so that one circuit may include more turns of the common winding than the other circuit; that is, one circuit may have for instance but five turns, while the other circuit has 15 or 20. But this adjustment to obtain coupling also varies the inductance of the circuit, and therefore the natural time period. I have explained that in the quenched-gap type there is necessity for adjustment of both coupling and natural time period, and it may be readily seen that where the adjustment of one of these factors affects the adjustment of the other, some difficulty may be had in calibration. With the two-winding transformer the coupling adjustment may be had by moving the two windings with respect to each other without interfering with the time period adjustment. Therefore, the better design requires two windings for facilitating adjustment, but this is not a matter bearing upon the [fol. 809] mode of operation of the apparatus, as in the open-gap type where very loose coupling is essential, and where the desired degree of loose coupling is very difficult to obtain in a direct-coupled type.

In this respect of direct coupling, this group of types directly descend from the Lodge 1898 patent which discloses the fundamental principle on which the quenched-gap type is based, which fundamental principle I have explained is the one of quickly dumping all of the energy from the primary circuit into the open radiating circuit, and then cutting off the primary circuit so that it will in no way

interfere with the action of the radiating circuit. Figure 4 of the Lodge patent, which illustrates the apparatus for executing his fundamental principle, has the primary and open radiating circuit related through a one-winding directly connected to both circuits, as is the case in this group of types.

In my opinion this group of types is entirely dissimilar to the Marconi open-gap type, because the types are all operated on the quenched-gap principle, and further dissimilar to the Marconi open-gap type, because of the direct-coupling relation between the two circuits at the transmitter which makes them particularly similar to the Lodge patent type.

In the Foote-Pierson type the receiving station also includes this feature of direct coupling between the two circuits, but I note that contrary to the testimony and the descriptive matter of plaintiff's exhibits, plaintiff's diagrammatic illustration of this receiver, Exhibit 102, shows two windings, one in black and one in red. The receiving claims in the Marconi patent also include the oscillation transformer having two windings. At the receiver it is also particularly desirable to have loose coupling, and therefore two windings which may be moved one with respect to the other, for obtaining a degree of coupling sufficiently loose for selectivity. While Lodge and the Marconi 1899 patent show the two-winding oscillation transformer at the receiver, the direct-coupled type of this Foote-Pierson apparatus was also shown in the Lodge patent, Figure 12, as well as in some of the receiver patents referred to in the Marconi specification.

I also find that in the following types of the group now under discussion, the receiving stations have untunable secondary circuits:

Telefunken type.

Foote-Pierson type.

These two types having untunable secondary circuits at the receiving station are therefore subject to the same comments of mine in connection with the previous group, wherein a number of the receivers had untunable secondary circuits.

The following types refer to receivers only:

Navy Specifications 16-R-2 (plaintiff's Exhibit No. 40).

Receiver arranged with terminals for any form of detector (plaintiff's Exhibit No. 113).

Vacuum tube receivers (plaintiff's Exhibit No. 114).

Direction finder (plaintiff's Exhibit No. 115).

Federal Telegraph Co. receivers (Fig. 89, plaintiff's Exhibit No. 78).

These receivers are all the same as that illustrated in plaintiff's Exhibit No. 87, Wireless Specialty Apparatus [fol. 810] type, and are subject to the same comment I have made as to that type. These receivers mainly show the use of vacuum tubes as detectors in lieu of the crystal detector shown in the Wireless Specialty Apparatus type, but my understanding of the Marconi patent is that it relates to circuit arrangements only, the type of detector being a matter not affecting the showing.

As far as this particular group of receivers is concerned, it is my opinion that the Marconi patent applies as equally well to the prior art as to these receivers, particularly to Figure 13 of the Lodge patent, Figure 1 of the Marconi 1899 patent, to the various receiver figures of the Stone patent, and to the Stone to Baker letters of June 30, 1899, and July 18, 1899. So far as these receivers have any bearing on the Marconi patent, they comprise an open absorbing circuit associated with a closed secondary circuit with means provided for adjusting the two circuits to be in tune with the incoming frequency of the radio signals. This arrangement is shown in Figure 13 of the Lodge patent, while the arrangement and the matter of tuning are fully shown and described in the Marconi 1899 patent and the Stone patent, and the Stone to Baker letters.

The witness, Clark, in paragraph 15 of his answer to Question 2, page 239 of the printed record, refers to devices termed "wave changers," which devices are discussed by plaintiff's witness Waterman, at page 263 of the printed record. I am thoroughly familiar with this device, having seen it embodied in many types of quenched-gap radio transmitters of the Navy. It merely amounts to a mounting having suitable coils for the primary and secondary of an oscillation transformer, together with such other windings as may be necessary to permit obtaining the necessary inductance in both circuits for the transmitter to be capable of transmitting at a number of different frequencies or wave lengths. The device also includes a switching arrangement

so that an operator in changing from one wave length to another can do so by merely throwing the switch from one position to another, the switch mechanically taking care of readjusting the inductance in each circuit to meet the new wave length setting. The Navy wave changers in general were provided for including anywhere from 3 to 9 different positions corresponding to assigned wave length or frequencies for communication, depending upon the service to which the apparatus was to be put. The necessity for this apparatus came about through the increasing use of radio, often making it necessary for the operator to quickly change from one wave length to another to avoid interference. In the old arrangement, it was necessary for the operator in changing his wave length to make a number of connections himself, and then by a cut and try method to ascertain when his apparatus was correctly adjusted. Quite often operators were not skilled in adjusting with the result that their efforts to adjust were very slow and frequently gave very poor results. With the wave changer device, the adjustment at each wave length was carefully made by an engineer skilled at this sort of work, and with these adjustments all connected to one switch arm, all the operator had to do in the practical operation of his set was to move the arm until an indicator pointed to a dial indicating the proper wave length, the apparatus itself automatically making the several adjustments, which had been set by the skilled engineer in calibrating the set. These wave changers were particularly designed to take care of the proper [fol. 811] adjustment of the quenched-gap type of set; that is, they included means for tight coupling and means for obtaining an approximate adjustment of the time period of the two circuits so as to secure a beat or point of no current in the primary circuit at the proper moment, and also a means commonly termed a "variometer" for throwing the adjustment of the time periods somewhat out of accord to secure beat perfection. The mere fact that these wave changers included arrangements for adjusting the inductance of the two circuits in which the device was connected does not mean that the adjustment was for the purpose of securing resonance between the two circuits as contended by Mr. Waterman, for in the quenched-gap type, resonance between the two circuits is not used, and the adjustments are for an entirely different purpose. If it could be contended that these wave changers were for the purpose of

securing resonance between the two circuits, then in my opinion, they would apply as well to the prior art as to the Marconi patent, for they simply included a one-switch means, not a part of the Marconi patent, for controlling the variably acting inductance coil of the prior Lodge patent, particularly illustrated in the radiating circuit, and the variably acting inductance coil described in the Stone patent in connection with the primary circuit and not described or illustrated in the Marconi patent, and the device as a whole is a most suitable "empirical" means for accomplishing the tuning of the two circuits together, referred to by Stone in his letter of June 30, 1899, to Baker.

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The next type, Federal Telegraph Co.'s Arlington arc transmitter, discussed by Mr. Waterman at page 211 of the printed record, I have already explained commencing page 513 of the typewritten record, is an entirely different organization from the spark type of apparatus disclosed in the Marconi patent. Commencing page 526 of the typewritten record, I explained in careful detail the difference between the arc type of transmitter and the spark type of transmitter. From a reading of Mr. Waterman's deposition, at page 212, I understand that he makes only a conditional contention that the Arlington arc transmitter is within the terms of the Marconi patent 763772, this condition being dependent upon whether or not the circuit containing the condenser *c* and the arc, marked "gap," in plaintiff's Exhibit 104 is a tuned circuit, that is, has the same natural time period as does the elevated conductor circuit, *f* to *E* inclusive, plaintiff's Exhibit 104. I understand that Mr. Waterman would contend that this type is within the Marconi patent if the two circuits are in tune, but admits that there is no evidence in the descriptive matter of plaintiff's exhibits leading to the belief that such tuning exists.

Even though such tuning did exist, it is my opinion that an arc type of transmitter is not within the terms of the Marconi patent. I have explained that the arc generates what is known as continuous waves instead of trains of waves as in the spark-gap type. There is no storing of a large amount of energy in a condenser which suddenly [fol. 812] breaks down a spark gap and starts a train of

oscillations which gradually die out and cease to await the recharging of a condenser for another train, and so on. In the arc type the stream of oscillations is continuous, and the arc is always active instead of part active and part idle as in the spark-gap type. There is no reservoir circuit storing a large amount of energy and slowly feeding it to another circuit, as in the open gap Marconi type. The energy is utilized at the same rate at which it is fed. The arc type operates from a low voltage source of direct current compared to the requirement of a high voltage source of alternating current in the spark type. For instance, the voltage in the arc type is in the neighborhood of 500, while in the spark type it is in the neighborhood of 10,000 to 25,000 volts. The spark type would be absolutely inoperative for practical purposes at such a low voltage supply. In the arc type, the continuity of the stream of oscillations can not be interrupted, for if this is done, the arc will extinguish and it will be necessary to manually strike the arc by forcing the two electrodes in contact. Signals can only be made by some method that does not interrupt the flow of current through the arc, such as changing the frequency or diverting the energy from a radiating circuit to a nonradiating circuit. In the spark type the oscillations are automatically interrupted between every train of oscillations, which happens in the neighborhood of from five hundred times to one thousand times per second, but since the spark type automatically creates oscillations these interruptions present no difficulty in this type, while they would be absolutely impossible in the arc type as it would be out of the question to manually restrike the arc five hundred to one thousand times per second. Also in the spark type, the key action to make signals actually starts and stops flow of supply current. This could not be done in the arc type as the arc would not reignite when the key is pressed to make a signal unless the arc electrodes are shoved together manually, and as these electrodes weigh anywhere from three to twenty pounds, depending upon the size of the transmitter, such action would be hopelessly unpractical. The Marconi claims require "means for automatically creating oscillations of the desired frequency." The arc type does not do this, as once it is started, it must not be stopped, for it is not automatically self-starting.

In my prior testimony I have explained in detail the difference in action in the arc itself from the action in the

spark gap, and think it unnecessary to repeat this explanation here.

On account of the entirely different action in the two systems, it is my opinion that no arc transmitter, no matter what its circuit arrangements are, can be said to be within the terms of the Marconi open-gap type of transmitter, and I have never heretofore encountered any contention that the two types have anything in common.

Returning now to the one condition on which Mr. Waterman contended that the Federal Arlington arc transmitter might be considered to come within the terms of the Marconi patent, that of having two circuits in tune, I am thoroughly familiar with the arc transmitters which have been installed by the Navy, as well as arc transmitters which have been installed in England and France, and know of no instance where two tuned circuits have been used between the time of the experimental radio telephone installations on vessels of the United States Fleet on the cruise around the world in 1908, such installation having been [fol. 813] made by Dr. Lee De Forest, and the experimental effort during the last two years to employ coupled circuits in order to meet a popular demand that Government arc transmitting stations be in some manner cured of their tendency to emit harmonics and so-called "much" which have proved somewhat annoying to the popular practice of listening in to radio broadcasting. This last experimental work is now resulting in the Navy redesigning its arc stations to include two coupled tuned circuits such as illustrated in Figure 29D, page 58, of plaintiff's Exhibit No. 78, Navy Manual of 1913, but this work has all been subsequent to the expiration of the Marconi patent. Heretofore all of the installations of arc transmitters have been as illustrated in plaintiff's Exhibit 104, except that the placing of a condenser *c* in shunt to the arc was long ago discontinued. For a time it was thought that such a condenser in some way acted to stabilize the action of the arc through keeping the current flowing therethrough more uniform, and to a measure prevented the production of undesirable harmonic and so-called "mush." Experience, however, taught that there was nothing gained by such a condenser and it was abandoned. Even with a condenser in shunt with the arc, there is no possible hope of contending that the circuit containing the condenser is a tuned circuit. There is no inductance in the same circuit, and the discus-

sion of tuning all through the testimony in this case clearly shows that a circuit to be properly tuned must have both inductance and capacity.

Plaintiff's Exhibit No. 104 also shows that the arc, marked "gap" in the diagram, is placed directly in the antenna circuit. The removal of the spark gap from the antenna circuit is the very foundation of the Marconi patent as stated in the specification, and the Arlington arc transmitter violates this foundation.

Mr. Waterman's deposition, page 212, also refers to Federal arc transmitters of plaintiff's Exhibits 65, 66, 67, and 68. These exhibits are Navy contracts with the Federal Telegraph Co. purchasing from time to time arc transmitters subsequent to the purchase of the Arlington arc. These subsequent purchases were all installed in the same manner as the Federal arc illustrated in plaintiff's Exhibit 104, and if the earlier ones were first installed having a condenser in shunt with the arc, a matter with which I am not familiar, this condenser was removed later, for I am familiar with the standard Navy practice and know that it did not include such a condenser.

Mr. Waterman refers to a part of the specification of the Navy contract comprising plaintiff's Exhibits 65 and 66, as follows:

"If it be necessary to use coupled circuits to give maximum antenna input, necessary condensers and inductances will be supplied."

I know that this condition of the contracts was never found necessary in practice.

Mr. Waterman also refers to a provision in the Navy contract comprising plaintiff's Exhibit No. 65, which provided "that the transmitting apparatus shall be so designed that by the operation of a single switch the energy radiated may be emitted either in wave trains or continuously, as desired."

It is difficult to interpret what this provision means, unless at the time of drawing the specifications for this contract, which was quite early in the Navy's experience with arc sets, it was meant that the company should supply both an [fol. 814] arc transmitter and a spark transmitter to operate on the same antenna, and by throwing a single switch either one of the sets could be put into operation. I know of no

such installation in the Navy, and do not believe that the Federal Co. ever supplied one.

It is my opinion that none of the arc type of transmitters, no matter how connected, apply to the Marconi patent 763772, on account of the differences in apparatus and operation which I have brought both here and in my prior testimony, but aside from this that none of the types of apparatus referred to by plaintiff had the circuit arrangement on which Mr. Waterman based his condition that the types might be said to come within the terms.

• • • • •
33. Question. In your last answer you pointed out that Mr. Waterman's sketch, plaintiff's Exhibit 102, purporting to illustrate the Foote-Pierson pack set, is inaccurate in showing two windings in the oscillation transformer. Will you submit a sketch illustrating correctly the Foote-Pierson pack set and also the Telefunken and Lowenstein set?

Answer. In my last answer I invited attention to the fact that Mr. Waterman's sketch, plaintiff's Exhibit 102, shows two windings in the oscillation transformer between the two circuits, one in red and one in black, but that the illustration of two windings is not in accordance with the testimony of plaintiff's witnesses in respect to this set, or in accordance with the exhibits of plaintiff describing this set, and that the same showing of two windings was made in the sketch illustrating the Telefunken type, plaintiff's Exhibit 79, and the Lowenstein type, plaintiff's Exhibit 101, also not supported by testimony of plaintiff's witnesses or the exhibit describing these types.

In a sketch marked "Loftin sketch P" I have illustrated my understanding of the type of connection between the two circuits in all of these three types, based upon the testimony of plaintiff's witnesses and the descriptive exhibits. The illustration of the transmitter of my sketch refers to all three types, while the illustration of the receiver refers to the Foote-Pierson type only. The sketch shows but a single winding interlinking the two circuits, the primary circuit being arranged to include any desired number of turns of the winding therein, and the secondary or open circuit also being arranged to include any desired number of turns of the winding therein. The number of turns in each of the two circuits need not be the same, and, in fact, they usually differ

widely. The arrangement is not a two-winding oscillation transformer, as illustrated in the Marconi patent and generally claimed.

34. Question. In your answer to question 32 you described the operation of the "wave changers" referred to by plaintiff's witness, Clark. Will you explain what determines the wave-length marks on the dials of these instruments?

Answer. The "wave changers" referred to by plaintiff's witness, Clark, were developed and designed for practical [fol. 815] use after the quenched-gap type of transmitter was adopted by the Navy as the preferred form, and therefore included in the design particular consideration for the conditions to be met in quenched-gap operation, particularly in the matter of obtaining tight coupling. Since in the quenched-gap type of apparatus the wave length or frequency is determined entirely by the wave length or natural frequency of the open or antenna circuit, the wave-length marks on the dials of these instruments would be determined entirely by the adjustment of capacity and inductance of the antenna or open circuit. In practice the wave lengths for a system are predetermined by the regulations governing the communication from the apparatus in accordance with the service which the apparatus is performing. The dials are marked with these predetermined wave lengths, and in setting up the apparatus for use when it is a quenched-gap type it is compulsory that the antenna or open circuit be adjusted to the dial marking irrespective of any other adjustments of the apparatus.

It was not possible, however, to use these wave changers with the open-gap type of transmitter, though I have never known one to be so used. If so used, the wave-length marking on the dial would determine the natural frequency of the primary circuit, as in the open-gap type the primary circuit has the duty of establishing the frequency of the entire system. That is, if of the open-gap type, assigned predetermined frequencies marked on the dials of the wave changers, it would be compulsory to adjust the frequency of the primary circuit to correspond to the markings irrespective of other adjustments.

35. Question. Can you refer to literature of the art supporting your views as to the difference between the Marconi persistent open-gap type of transmission and the defendant's quenched-gap type of operation?

Answer. Practically every piece of literature of the radio art that considers the matter of the Marconi persistent open-gap type of transmitter and the quenched-gap type of transmitter supports my view as to the difference between the operation of these two types. For sake of brevity of the record, I will refer to only a small part of the literature, having chosen the literature of the best recognized authorities.

A very early reference to this difference is contained in an article by J. A. Fleming in *The Electrician*, of London, June 11, 1909, commencing page 332. Professor Fleming has written a number of very elaborate textbooks on the subject of radio, commencing as early as 1906, and is recognized internationally as an authority on the subject. The article opens as follows:

"In my lecture last Friday evening at the Royal Institution time did not permit me to do more than give a brief description and show one experiment with the multiple small-gap flat plate discharger which has been devised by the experts of the *Gesellschaft fur Drahtlose Telegraphie* for giving practical effect to Prof. M. Wien's method of excitation by shock in spark telegraph."

Professor Fleming's reference to "the multiple small-gap flat-plate discharger" clearly conveys to one skilled in the art that he had reference to the quenched-gap type of transmitter. His reference to "excitation by shock" clearly shows that he was differentiating the new method from that of the Marconi open-gap type, in which the excitation [fol. 816] of the antenna was not accomplished by shock action or by "impulsive rush," as described by Lodge, but by the slow feeding, nonshock action from a reservoir, persistently oscillating circuit.

The article then points out that Professor Fleming in a previous lecture brought out the fact that when two circuits are coupled and the spark in the exciting circuit endures for a long time oscillations are produced in the system at two frequencies, and explains that this was illustrated by two pendulums coupled through a loose string. Professor Fleming states that the new system he is discussing is based on the principle of stopping the oscillations quickly in the exciting circuit, leaving the energy free to oscillate with a single period in the secondary circuit, and he illustrates this in a figure, Figure 1, accompanying the

article, in which the first two diagrams illustrates the action occurring in the open-gap type of transmitter when the coupling is sufficiently tight to transfer the energy back and forth between the two circuits, producing alternate beats of no energy, just as I have done in my sketches. The second pair of diagrams of the figure illustrates the action in the new system, the quenched-gap type, under discussion by Fleming, it being shown that the oscillations in the primary circuit are quickly stopped, being cut off at the first beat, leaving all of the energy in the secondary circuit to oscillate at one frequency determined by the natural frequency of the secondary circuit.

Professor Fleming then describes the construction of the new type of gap responsible for these results as follows:

"The discharger I used consisted of 12 round flanged plates of copper, 5 inches in diameter, the surfaces being turned true and having a groove in them. (See fig. 2.) A mica ring is interposed between each pair of copper plates of such size that the mica half covers each groove. This groove is important, for without it the discharge spark tends to take place always at the edge of the mica. The mica is of such thickness as to make an air space of not greater than 0.01 inch between the flat copper surfaces. In this discharger we have then, say, 11 air gaps, each about 0.01 inch wide and of circular section. When this discharger replaces the ordinary spark-gap in the primary circuit it damps out instantly the primary spark, and hence excites the free oscillations in the secondary circuit by shock. If, then, we place the cymometer alongside of the secondary circuit we find in it oscillations of only one frequency and not two. Also, if we place it alongside the primary circuit, we can not detect in that circuit any oscillations, because they are so rapidly damped out that they have too small a mean square value to affect the cymometer or cause the Neon tube to flow perceptibly."

The gap described in the quotation is illustrated in Figure 2 accompanying the article, and an examination of this figure clearly shows the division of the total spark-gap length into a number of short gaps by the use of a plurality of disks of large area provided with flanges for good cooling. Professor Fleming speaks of the use of 12 of these disks, which makes it readily apparent that a large amount

of metal is in use over which the heating is distributed, provided for low distributed temperature as well as excellent opportunity for dissipating the heat. The material of the disks is stated to be copper, which is a good conductor of [fol. 817] heat and which also does not easily vaporize. The short length of each division of the spark gap provides the necessary opportunity for quick deionization of the gap spaces through dispersion of ions and electrons to the electrodes. The article later states that the copper may be silver plated, and in the case of large discharges arrangements for water cooling through making the disks hollow may be used.

Thus the spark-gap construction described by Professor Fleming included many of the requirements which I have previously explained are necessary for rapid deionization to obtain good quenching as compared to the necessity for maintaining ionization for persistent oscillation in the Marconi open-gap type. The multiple disk type of spark gap illustrated in Figure 2 of the article is in all general arrangements and construction the same as that which has been universally used in quenched-gap transmitters. Some improvements have been made looking toward more efficient cooling, such as increasing the extent of the cooling flanges, while other improvements more or less go to the matter of ease of assembly and disassembly of the gap structure, as well as switching in or out any desired number of gap units.

The quotation of the Fleming article states that when this new type of spark gap replaces the ordinary type it damps out "instantly" the primary spark and, hence, "excites the free oscillations in the secondary circuit by shock." It is certainly obvious from such language that Professor Fleming at that early date appreciated the great difference of operation between the open-type gap transmitter and the new quenched-gap type.

The quotation refers to a simple method of determining that oscillations of only one frequency existed in open or antenna circuit, and that oscillations were rapidly damped out of the primary circuit. The article is concluded with the following statement:

"Finally, as the whole of the energy transferred to the secondary circuit expends itself in the production of radiation of one single wave length it must be more economical

than methods which generate waves of two wave lengths, but capture at the receiver radiation conveyed by only one of these wave lengths."

This is a very clear statement, recognizing that in a quenched-gap system all of the energy is dumped into the antenna, where it acquires a frequency of oscillation determined by the natural period of the antenna and is thus usefully employed in the production of radiation of one single wave length, as compared to a system in which the energy remains in both circuits during the entire time of radiation resulting in waves of two frequencies, Fleming having in mind here that in the open-gap type no matter how loose the coupling, there are, in fact, two frequencies, and that the energy must be distributed over these two frequencies instead of concentrated in one frequency.

Immediately following the article above referred to, Fleming has another article commencing at page 333 of the publication entitled "The utilization of the total radiation from an inductively coupled antenna in radio-telegraphy." Fleming describes in this second article the same quenched-gap system and states, near the bottom of page 333:

"The primary spark is then quenched with great rapidity and the action upon the secondary or antenna circuit is of the nature of a blow or shock, setting up the free oscillations of the secondary. For this reason this method of excitation is called, in Germany, 'Stossenregung'."

Thus again he describes the new system as one which excites the antenna by "a blow or shock," thus clearly differentiating it from the Marconi open-gap, slow-feeding reservoir system. It is, of course, clear from such language that Fleming did not consider that there was any such thing as a resonant transfer of energy between the two circuits in this "blow or shock" action. In discussing the Lodge patent in suit, which has to do with inserting an inductance coil in the circuit to cause the oscillations to be long drawn out or persistent, Mr. Waterman and I have both pointed out that unless the oscillations are sufficiently long drawn out or persistent, as stated by Lodge, there is no resonant action or resonant transfer of energy. This, of course, is just as true in the quenched-gap type of sys-

tem as in any other system in which energy is being transferred, and this reference by Fleming to a "blow or shock" excitation of the primary circuit upon the secondary circuit naturally compels the thought of no resonant energy transfer.

In the *The Electrician*, of London, November 10, 1911, commencing page 171, there is an article entitled "The Telefunken system of wireless telegraphy," which clearly describes the quenched-gap system discussed by Professor Fleming in the article I have just referred to. In fact, Figure 1 of the second article, which illustrates the oscillations in the two circuits, is undoubtedly a reproduction of Figure 1 in the Fleming article, and Figure 8 of the later article, illustrating the structure of the quenched gap, is undoubtedly a reproduction of Figure 2 of the Fleming article, which illustrates the structure of the quenched gap.

This later article discusses the quenched-gap action in very much the same way as does Fleming, but includes the following statement on page 172 concerning a matter not touched upon by Fleming:

"To give the best result it is necessary that the reaction of the secondary circuit should assist the quenching in the primary, and for the reason the two circuits are slightly mistuned, namely, to the extent of about 2 per cent. The closer the coupling the greater must be the mistuning."

I have previously stated that the arrangements in the quenched-gap type of apparatus for adjustment of capacity and inductance of the two circuits are not for the purpose of obtaining a resonant relation or resonant transfer of energy between the two circuits as is the case in the Marconi open-gap type of transmitter, but for an entirely different purpose, that of securing adjustment or control over the time or point of producing a beat or period of no current in the primary circuit at which time quenching may take place, and that, in fact, the proper adjustment results in the two circuits being somewhat different in the time periods in order to secure a currentless or perfect beat. The language I have quoted above bears me out in this statement, and points out that the closer the coupling between the two circuits the greater must be the difference between the time periods.

I have already referred to United States patent 1216615, of February 20, 1917, to Seibt, defendant's Exhibit C-3, in

which there is a clear explanation of the operation of a quenched-gap system supporting my view of the operation, and which clearly shows that the operation is entirely different from the Marconi open-gap type. Figures 12, 12a, 13, and 14 of the Seibt patent illustrate the multiple disk type of spark gap, very similar to that illustrated in the Fleming article, and which is clearly described by Seibt in the matter of characteristics necessary to obtain rapid quenching as opposed to persistently oscillating as in the Marconi open-gap type.

I now refer to *Wireless Telegraphy*, by Zenneck, as translated from the German by A. E. Seelig, 1915. Professor Zenneck is an internationally recognized authority in the subject covered by his book. At page 87, article 58, Professor Zenneck clearly brings out that when two circuits of an oscillatory character are coupled, there result oscillations of two frequencies not the same as the natural frequency of the circuit. At page 88, article 59, the mathematical relation between the natural frequency of the two circuits and of the two coupling frequencies is given. In Figure 124, page 89, there is shown photographic oscillograms of actual circuits showing that when coupled there results an alternate transfer of energy between the two circuits resulting in alternate beats of no energy in these circuits. Figure 125, page 89, shows a photograph of sparks produced at the spark gap inserted in coupled circuits which clearly show that there is an alternate transfer of energy between the two circuits. Commencing page 93, article 62, Professor Zenneck discusses the quenched-gap type of system. In Figure 130, page 94, there are two diagrams showing the alternate transfer of energy between the circuits, resulting in beats of no energy alternately in each of the circuits when there is no quenching action. Figure 131, on the same page, shows the result of quenching the primary circuit at the first beat. These figures agree with the illustrations I have previously made and described, as well as those of the Fleming article and the Seibt patent I have previously referred to.

Figure 132, page 94, illustrates photographs of sparks produced in two-coupled circuits in which there is quenching action, the photographs clearly showing that the oscillations exist for a very short time in the primary circuit and endure for a long time in the secondary circuit.

At pages 94 and 95 Professor Zenneck describes the quenching action and resulting oscillations as follows:

"The conditions may be such, however, that the spark gap, during the time in which the amplitude in the primary circuit is very small, becomes so deionized that the EMF induced by the secondary is no longer sufficient to start or 'ignite' a spark discharge across the gap. As a result the spark gap remains quenched—whence the terms 'quenching action' or 'quenched gap.' The oscillations in the primary then discontinue entirely and the secondary circuit continues to oscillate with its natural damping and at its natural frequency just as if the primary circuit did not exist."

I invite particular attention to the similarity of this language of Zenneck to that of Lodge in his 1898 patent, where the principle of quickly exciting the antenna circuit with energy from a primary circuit, and then severing relation between the two circuits in order that the antenna circuit would be left free to oscillate at its own natural frequency and uninfluenced by any maintained connection with the primary circuit.

[fol. 820] Page 95, article 63, Zenneck describes various types of gaps suitable for quenching and the necessary characteristics of these gaps, pointing out the characteristics that I have previously referred to in detail.

Commencing bottom of page 96, Zenneck states as to the manner of throwing the two circuits somewhat out of adjustment as to time period as follows:

"The pureness of the pulsations probably also plays a part in the explanation of the fact that by bringing the primary and secondary circuits slightly out of resonance, a pure quenching can be obtained, after the quenching had been spoiled with primary and secondary entirely in tune."

Thus, Zenneck supports my statement that the arrangement for adjusting capacity and inductance are not for the purpose of obtaining a resonant transfer of energy between the two circuits, but for obtaining pure quenching to stop further transfer of energy between them.

On page 97, article 65, Zenneck covers the requirement of a gap for quenching action, preceding a detailed statement of requirements, such as I have previously covered

in detail, by a statement of the fundamental object sought, that of quickest possible deionization, as follows:

"The general requirement for the best quenching action is identical with the requirement for the quickest possible deionization of the spark gap."

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I next refer to a book entitled "Wireless Telegraphy and Telephony," by Eccles, published at London by Benn Bros., in 1918. Doctor Eccles is internationally accepted as an authority on the subject matter of this book. Commencing page 199 of the book, Doctor Eccles discusses the quenched-spark type of apparatus under the title of "Quenched-spark methods." Doctor Eccles opens the discussion as follows:

Probably all short-spark dischargers set their circuits into oscillation by what is variously called 'impact' or 'shock' excitation; and the terms 'short spark' and 'quenched spark' are often taken to be synonymous. Max Wien published in 1906 the first full account and explanation of the phenomenon. His explanation is expressed diagrammatically in Figure 110. The two curves (a) show the beating oscillations (on a time base) produced in a tuned pair of coupled circuits by a persistent spark in the primary; the curves (b) show how the quenching of the spark at an early stage leaves the secondary circuit in possession of all the energy and free to vibrate with its natural frequency. The damping of the primary should be at least ten times that of the secondary. Thus quenching ensures singleness of frequency."

Examination of Figure 110 referred to in the quotation shows that it is pre-*isely* the same as that of Fleming, Zenneck, and Seibt, previously referred to by me, and to the illustrations I have included in my sketches of the effect that takes place between two closely coupled circuits, first, when there is no quenching in the primary circuit allowing the energy to alternately transfer from one circuit to [fol. 821] another, alternately producing beats of no energy; and, second, when the gap is of the type designed to quench at the end of the first beat in the primary circuit leaving all of the energy in the secondary circuit to oscillate at the natural period of the secondary circuit uninfluenced by any maintained connection to the primary circuit.

It will be noted that Doctor Eccles points out that the first condition is obtained through the use of a "persistent spark in the primary"; that is, the type essential to the Marconi open-gap system, where persistency of oscillations in the primary is the fundamental basis of the Marconi system. I have fully explained, however, that the Marconi open-gap system in addition to having a persistent spark in the primary must also have loose coupling between the two circuits so as not to transfer the energy alternately back and forth between the two circuits with the beat phenomenon illustrated in the first pair of diagrams in Figure 10 of the Eccles article, but to have a slow feeding of the energy from the primary circuit, acting as a reservoir, to the secondary circuit at the rate that it is radiated by the secondary circuit.

Eccles explained that the second effect is obtained by the use of "short spark" or "quenched spark," remarking that the two terms are synonymous, and that it is this kind of spark that is responsible for a very early stopping of oscillations in the primary circuit and leaving the energy all in the secondary circuit free to vibrate with the natural frequency of the secondary, thus insuring singleness of frequency. It is, of course, to be understood from such explanation that this singleness of frequency is determined by the open or secondary circuit, and not, as in the Marconi open-gap type, determined by the primary circuit and maintained single through a loose coupling and a careful adjustment of the two circuits for a resonant transfer of energy at the frequency determined by the primary circuit.

Eccles refers to the type of transfer of energy between the primary and secondary circuits in the quenched-gap type as "impact" or "shock" excitation. This, of course, forbids any idea of a resonant transfer of energy between the two circuits. In the discussion of the Lodge patent in suit, it was clearly brought — that Lodge taught there could be no real resonant transfer of energy in impact or shock excitation systems; that is, systems in which the oscillations were not drawn out for a long time or persistent. The Lodge teaching applies as well to the transfer of energy between the primary and secondary circuit of a transmitter as well as between the radiating circuit of a transmitting station and the absorbing circuit of a receiving station.

On page 200 Doctor Eccles explains that one of the important features in good quenching is having short gap lengths with provision for rapid removal of the heat. This is in accord with what I have said and with the publication I have referred to.

At the bottom of page 200 Doctor Eccles gives a small table showing that in the quench-gap system there is no precise adjustment of the time periods to accord, but, rather, that there is a considerable difference between the time periods of the two circuits in a properly arranged quenched-gap transmitter. Adjustment IV of the table gives a coupling of 18.2 per cent, which is approximately the percentage of coupling used in ordinary practice, though probably a little under the average value. Doctor Eccles shows that under such circumstances the primary wave length should be 1,230 meters for a wave length in [fol. 822] the secondary of 1,340 meters. This is a difference of 110 meters, or approximately 10 per cent, and any such difference of adjustment in the open gap, loose coupled, persistently oscillating primary of the Marconi type would be absolutely ruinous to the system.

The discussion of Doctor Eccles is quite brief but extremely pertinent, making it clear that the quenched-gap type in no way has an operation the same as the open-gap type, and even in its proper adjustment depends upon an adjustment of the two circuits to be different as compared to the Marconi system in its proper adjustment, requiring a very precise adjustment of the two circuits to accord.

I next refer to a book entitled "The Principles Underlying Radio Communication," second edition, Signal Corps, United States Army, published at Washington by the Government Printing Office, 1922, in which book, at page 378, I find the following statement:

"It is well to note that the principles of operation of the quenched gap and plain gap are exactly opposite. The former aims to stop the primary oscillations quickly, after the secondary has been brought to full activity. The latter aims to keep the primary oscillations going as long as possible, all the time giving energy to the secondary as it is radiated away; the coupling is loose and the primary decrement is kept low. The rapid decrease of the oscillations in a quenched-gap circuit is assisted by having a large ratio of capacity to inductance. This has the incidental advan-

tage that the voltages across the condenser and coil are thus kept low."

This very clear and brief summary of the differences between the quenched-gap system and the Marconi open-gap system is prefaced by the comments that the principles of operation are "exactly opposite." It well sums up the matters I have explained in detail which go to make the principle of operation exactly opposite from that of the open-gap type.

I next refer to a book entitled "Wireless Telegraphy," by Leggett, published at New York in 1921 by E. P. Dutton & Co. The author of this book clearly brings out that he is an Englishman and has the following to say in the opening paragraph of the author's preface:

"It is a matter for comment that whilst numerous works have been published, and others are still being produced, dealing with the highly important science of wireless telegraph, yet none of these give more than a mere outline of the quenched-spark system, a system which has been employed in almost every country throughout the world. In view of its extensive adoption in such countries as the United States of America, Australia, Japan, China, and Germany, and considering that it can for land stations claim to rank with the Marconi system in importance, this lack of literature in England is difficult to understand. It is, however, probably the result of national prejudice, since the system had its origin in Germany, where it was experimented with and established by the Telefunken Co."

At page 9 of the book Leggett says:

"In Fleming's treatise the achievements of Mr. Marconi and the apparatus of the Marconi Co. are dealt with at great length, but it is a matter for comment that the apparatus of this company's greatest competitor, namely, the Telefunken and quenched-spark system, receives very [fol. 823] scanty notice, and, indeed, its name does not appear in the index to his book.

"Eccles's book is far more general in nature, but as the book is much more restricted in size, his matter on the Telefunken and quenched-spark systems is necessarily small."

Professor Fleming and Doctor Eccles are both Englishmen, it being a matter of common information that Fleming is affiliated with the Marconi Wireless Telegraph Co. of Great Britain. The author of the book I am referring to charges Professor Fleming with deliberately suppressing in Fleming's book information concerning the quenched-gap system, but condones scanty information in Doctor Eccles's book because of the restricted size of the book.

Continuing, on page 9, Leggett states:

"The average English reader is practically unaware of the existence of any important commercial system of wireless telegraphy other than that of the Marconi Co., and is quite astounded when told of the existence of another system which, outside England and a few of its colonies, is perhaps for land stations the most extensively adopted by other countries."

Thus the author points out the successful outcome on the public mind of suppressing information concerning the quenched-gap system. The author then next touches upon the relative efficiency of the two systems, stating at page 9 as follows:

"There is, however, only one test of any scientific apparatus, namely, its efficiency. Since the quenched-spark gap has at least twice the efficiency of any other form of spark gap, it is far from patriotic to neglect the possibilities of this system. On the contrary, it is a truer form of patriotism to examine, impartially and scientifically, the merits and demerits of foreign scientific work, German or otherwise, and then to utilize the results of such examination to the furtherance of British science and technology."

There is no difficulty in appreciating the foundation for Leggett's statement that the quenched-gap system is twice as efficient as the Marconi open-gap system. In the quenched-gap system the energy is immediately delivered to the secondary circuit, where it is practically all expended in useful radiation, there being only a small loss in the small resistance of the antenna wire, while in the Marconi system the energy is retained in the primary reservoir circuit, where it for a long period of time is occupied in making heat, noise, and light in the spark gap as well as overcoming the resistance of the wire in the primary

circuit, and these losses in the primary circuit are large and must be deducted from the total energy that is available for a slow feeding to the secondary or antenna circuit.

Leggett, at page 17, then points out the practical effect upon British shipping of continuing to employ the less efficient Marconi open-gap type:

"As evidence that the only true test of any scientific apparatus depends upon actual results, the author might mention the following incident described by an English paper, The China Coast Shipping Gazette, as long ago as 3d November, 1911.

"The English steamer *Brodmore* was in Hankow's harbour in distress with a perishable cargo of meat. The skipper, owing to destruction of the land lines by insurgents, was unable to wire to Shanghai for a relief ship to salve his cargo. He approached the British consul with [fol. 824] a request that a British warship in harbour should be utilized to send a wireless message to Shanghai and was informed that the wireless range of this warship was insufficient for it to do so. Lying in the harbour was the German warship *Leipsig* fitted with Telefunken apparatus. As it was in permanent communication with the German warship *Nurnberg* in Shanghai the captain of the *Leipsig* offered to assist the *Brodmore* skipper by sending his message, the cargo so being eventually salvaged.

"The above-mentioned paper quoted upon the incident to the following effect: 'The system upon which the English Navy depends shows itself in a very bad light, and the English ships are unable to bridge large distances, while the German warships fitted with the Telefunken system are in easy permanent direct communication between Hankow and Shanghai. The German warship *Leipsig* in Hankow is, we hear, in permanent communication with the *Nurnberg* in this harbour, and exchanges regular communication between Nanking and Tsingtau, a distance of 260 miles, and, under favorable conditions, between Hankow and Tsingtau, a distance of not less than 450 miles.' "

At pages 55, 56, 57, 58, and 59 Leggett goes into the matter of the difference of operation between the open-gap type and the quenched-gap type. At page 55, Figure 13, he shows the usual diagrams for the alternate transfer of energy between two coupled circuits having alternate beats

in each circuit. At page 57, Figure 14, he shows the usual diagram of the effect of quenching at the first beat in the primary, leaving all of the energy in the secondary free to oscillate at the natural period of the secondary. Near the bottom of page 57 he states:

"As, however, unless one recognizes the differences in coupling in the original curves the whole difference between open and quenched gaps is apt to be overlooked, the author has taken the liberty of redrawing them in a series of curves (fig. 15), each of which show the open and quenched gap curves for the same particular degrees of coupling.

"In the case of the open-gap curves when quenching does not occur, the curve will be found to have two distinct peaks of very different wave length and low current value, which is proportional to the energy radiated."

Here Leggett lays stress on recognizing the difference in degree of coupling that is permissible in the two systems, and the diagram on page 58, Figure 15, clearly illustrates the importance of this feature, showing how utterly impossible it would be to endeavor to use the open-gap system with a degree of coupling permissible in the quench-gap type. For instance, diagram C of the figure illustrates what happens in the case of a coupling of 16 per cent. The diagram shows that with this degree of coupling the transmitted signal from the quenched-gap type, illustrated in the full-line curve, is very peaked or sharply resonant and strong. Such a signal would allow a distant receiver to tune to it very sharply, excluding other interfering signals, and getting a strong signal from the transmitter. The dotted-line curve shows the type of signal that would be radiated from an open-gap installation having the same coupling between circuits. It is seen that there are two humps, neither one *one* of them being half as strong as the [fol. 825] quenched-gap signal. The distant receiver would be able to find this signal over quite a wide range of tuning, but would not be able to receive the signal at any tune at anywhere near as great a distance as with the quenched-gap signal. Other receivers in the vicinity would also be able to receive the open-gap signal over a very wide range of tuning, with the result that they would be seriously interfered with in the matter of trying to receive their own signal from a station supposedly on a different assigned

frequency from that of the open gap. The selectivity or, as termed by Marconi in his patent, "localization," the object of the Marconi patent, is measured by the sharpness or peakedness of these curves, and it is easy to see that the broken-line curve of the open-gap type is in no way sharp or peaked suitable for selectivity.

Diagram D of the figure compares the resulting signals with a coupling of 11 per cent. In this diagram the quenched-gap curve is very sharp and suitable for extreme selectivity, showing that the frequency is determined by the open of antenna circuit uninfluenced by a connection to the primary circuit. The broken-line curve of the open-gap type shows that the two humps or two frequencies are beginning to become close or nearly the same, but not nearly so strong as or sharply defined as the quenched-gap curve. While the energy is more nearly concentrated than in the case of the C diagram, yet it is not much stronger, because the coupling has been loosened, resulting in a lower rate of transfer.

The diagram at the bottom of the figure compares the quenched-gap curve with a coupling of 11 per cent with the open-gap curve with a coupling of 4.5 per cent. It will be seen that in the matter of sharpness or peakedness, these curves compare quite favorably. The text, however, points out that it requires two and a half times the energy input in the open-gap type to obtain the same strength of signal as in the quenched-gap type. The text states, page 59, the efficiency relation as follows:

"The last curves of this series show the difference of coupling necessary to obtain the same current effect with open and quenched gaps. These couplings are, according to Fleming, 11 per cent for the quenched gap as opposed to a much weaker coupling of 4.5 per cent for the open gap. This means that the coupling must be weakened and therefore a less transference of energy from excitation and aerial circuit takes place, and to render the aerial currents equal much greater energy in the prime circuit must be present. According to Fleming's figures it would be pre-

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sumably necessary to use — = 2.5 times the prime energy to

4.5

obtain the same aerial energy, i. e., with the quenched gap the efficiency is about 75 per cent if we take the usual value

of 25 per cent for the open gap, a figure for the quenched gap which has been questioned by its opponents."

The Marconi specification speaks of efficiency, and his system provides for obtaining a certain kind of efficiency. For instance, comparing diagram- C and D of the figure, it will be seen that the looser coupling arrangement of diagram D is more efficient than the tighter coupling arrangement of diagram C, because the energy in diagram D is more nearly concentrated into one peak than in diagram [fol. 826] C. Also, by having a loose coupling which permits of practically one frequency in the primary circuit allows a resonant transfer of energy by precise adjustment of the two circuits to accord, and a resonant transfer is always more efficient than a nonresonant transfer. The efficiency obtained in the quenched-gap type is entirely of a different kind from that of the open-gap type. It comes about through a quick transfer of energy between the two circuits in a nonresonant way to remove the energy from a system, the primary circuit, and its spark gap, in which the losses are high, and to confine it to a system in which the losses are low, namely, the antenna circuit.

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From pages 60 to 63 Leggett describes the structure of gap elements for good quenching, bringing out the desirability of cooling, the use of flat disks instead of more or less pointed electrodes, the choice of materials of electrode surfaces, the division of the total gap length into a number of short lengths, and mentions protection of the gap from ultra-violet light as did Lodge in his early disclosure (1898 patent) of the fundamental principle on which the quenched gap system is based.

Summarizing, the literature of the art supports my view that the quenched-gap system employs a coupling between the primary circuit and secondary circuit so close (in the neighborhood of 20 per cent) that if used with a gap of the persistent type as required by the Marconi or Stone open gap type, there would result two frequencies so widely separated as to render the system worthless in the matter of localization of communication and efficiency, and with such coupling there is no possible chance of the primary circuit automatically creating oscillations of the desired frequency

as required by the Marconi specification and claims, nor can there be a resonant transfer of energy between the two circuits, as the circuits are tuned to one frequency while the oscillations are two in number and of entirely different frequencies from the circuits. That with tight coupling, even though the persistent type of gap is used, there is no reservoir action in the primary circuit slowly feeding energy into the secondary circuit at the rate it can be radiated, because the energy is rapidly alternately transferred between the two circuits, and the two circuits are therefore alternately reservoirs of the energy of the combined systems. The art shows, as I have contended, that the energy in a quenched-gap system is quickly dumped in its entirety into the secondary circuit from the primary circuit, and that when this function is completed, the quenched gap opens up and effectively puts the primary circuit out of action from the point at which the secondary circuit commences to effectively radiate energy at the desired frequency, and that it is this secondary circuit which is responsible to the system as a whole including the receiver for setting the frequency of the oscillations, instead of the primary circuit as in the Marconi or Stone open gap system. The art makes clear that the transfer of energy between the primary and secondary circuits in the quenched gap system is of the "shock" or "impact" type, which is not capable of resonance in the sense of a resonant transfer of energy as fully explained by Lodge in his 1898 patent, [fol. 827] because its duration is too short to employ a resonant building up through a cumulative effect, and furthermore, that the transfer takes place at two frequencies so widely separated one from the other and from the frequency of either one of the circuits that there is no common frequency anywhere in the circuits or oscillating energy on which the consideration of resonance can be based. The art brings out that in fact the two circuits do not even have the same natural time periods, for a proper adjustment of circuit relation to obtain good quenching requires throwing the two circuits somewhat out of adjustment to obtain a currentless beat to give opportunity for complete deionization of the gap. And the art lays great stress on the fact that the characteristics of the gap itself in the quenched gap type are directly opposite to the characteristics of the gap in the Marconi or Stone open gap type—the former must act to quickly stop the flow of current and

the latter must aid to make the flow long drawn out or persistent.

36. Question. What has been the commercial history of the persistent open-gap type and of the quenched-gap respectively?

Answer. In the Navy as soon as the quenched-gap type became an assured successful design of radio transmitter, which was about 1911, it was immediately adopted as the standard type of transmitter for ship stations and low-power and intermediate-power shore stations, the old type of open gap, transmitter being replaced by the new type of quenched gap transmitter as rapidly as funds became available. At first, the new type was not commercially available in American manufacture, and many sets of the quenched-gap type were purchased from the German Telefunken Co., this Telefunken type being illustrated in plaintiff's Exhibit 79. I have in recent years examined the records of purchases of radio apparatus of both the United States Army and the United States Navy since 1910, and while an extremely large number of sets were purchased since that date, particularly during the war, I do not recall a single instance of purchases of the open-gap type in the records which I have examined, and in fact, am familiar with the use of the open-gap type in but a few instances since 1910, these instances being in the case of the battleship division of the United States Fleet which joined the British fleet in its North Sea operations. The ships of the British fleet were equipped with a special arrangement of open gap transmitter employing an extremely and unusual degree of loose coupling, these sets being for the purpose of communication within the fleet only, the theory being that by using such a loose coupling resulting in a very inefficient order of radiation, that the signals would be heard only 10 or 15 miles at the most, thus keeping the fleet communications probably secret from the Germans. The ships of the American division were promptly equipped with this type of apparatus obtained from the British in order that their communication scheme would conform to that of the fleet which they had joined. This of course, was a use in which dependence was being placed upon inefficiency in the matter of communication and the open-gap type was particularly suitable.

The Navy during the war assumed the task of equipping all of the ships of the Shipping Board and Emergency Fleet

Corporation with radio apparatus, the ships being those taken over from private shipping companies and those built [fol. 828] by or under contract for the Emergency Fleet Corporation, and all of these ships were equipped with quenched gap apparatus.

When the war came on, there arose the necessity of providing radio apparatus for airplanes, and a large number of radio transmitters of the quenched-gap type were purchased in this country and in England for equipment of naval airplanes.

In the book by Leggett I have just previously referred to, pages 10 and 11, there is shown a table of the land radio stations of the world compiled from the International List of Radio Telegraphic Stations up to June, 1913, which shows that, even at that early date, 129 of the land stations of the world were of the Telefunken quenched-gap type, as compared to 138 of the Marconi type. Many of the miscellaneous stations in the list are not classified as to type, but 59 stations are listed as belonging to the United States Government, and in 1913, most of these were of the quenched-gap type. In the same book, page 14, there is shown a list of the ship stations of the world compiled from the International List of Radio Telegraphic Stations up to June, 1913, which shows that 579 ships at this early date had the Telefunken quenched-gap type as compared to 1,081 having the Marconi type. The list also shows a number of miscellaneous installations not classified as to type, but includes 214 vessels of the United States Government, a large number of which at that date had the quenched-gap type. The author, page 13, in accounting for the large number of ships having the Marconi type, points out that England, under the control of the Marconi Co. in the matter of radio apparatus, has a relatively much greater mercantile marine, as follows:

“Whilst it will be seen that the largest number of ships’ installations are those on the Marconi system, in estimating the relative importance of the Telefunken stations we must bear in mind—

“(1) That England as compared to any other nation has a relatively much greater mercantile marine, and therefore offers much greater scope for any wireless company operating in England.

"(2) The original Telefunken apparatus was not developed for ship work and did not enter upon such installation work until relatively late in wireless history.

"As far as naval ship stations are concerned, with the exception of Britain and Italy, these are either manufactured by the Telefunken Co. (Germany, Holland, Russia, South America Latin nations, etc.), or are modifications of this system. They are, however, not specified as such in the Berne list and therefore not given as such in the above figures."

The Marconi Co. of America was somewhat slow in adopting the quenched-gap type for its own commercial land stations and for ships with which it had contracts for providing radio service and suffered much criticism in the radio field for its adherence to the old type open-gap system. Before the war the market for radio apparatus in the commercial field was extremely limited, the Government at that time being the principal buyer. The Government insisted upon having the best obtainable and in seeking this line of business the Marconi Co. of America was forced to develop quenched-gap apparatus to meet Government specifications in order to compete with numerous other companies in the field of supplying Government radio apparatus.

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[fol. 829] 37. Question. Mr. Waterman in answer to question 30 produced a drawing, plaintiff's Exhibit 105, purporting to illustrate the defendant's apparatus involved in the case of this plaintiff against the National Electric Signaling Co., 213 F. R. 815. Will you say how the defendant's apparatus involved in the case referred to, and also the defendant's apparatus involved in the later case of this plaintiff against the Kilbourne & Clark Manufacturing Co., 239 F. R. 328, compare with the defendant's apparatus involved in this case?

Answer. Mr. Waterman in his sketch, plaintiff's Exhibit 105, illustrates the National Electric Signaling system as comprising the plain or open-type or spark gap, the quenched-gap type, and the rotary-gap type. I have carefully examined the decision of Judge Veeder in the case of plaintiff against the National Electric Signal Co., 213 F. R. 815, and fail to find any evidence in the opinion of Judge Veeder having considered anything but the plain

or open-gap type, this being at page 849 of the report, where he states:

“While in the defendant’s apparatus the loose coupling emits only one wave and admits of electric resonance.”

This conclusively shows that defendant’s apparatus in that case which was considered in Judge Veeder’s opinion was of the Stone or Marconi plain-gap type, depending upon loose coupling to allow the oscillations in the primary circuit of the transmitter to be of one frequency and admitting of electrical resonance between the primary circuit, and the secondary circuit. In defendant’s quenched-gap type the coupling is tight to the extent that two decided waves would be emitted, in the absence of a quenched gap, and there is no such thing as electrical resonance between the two circuits either with or without a quenched gap, for in both instances, while energy is being transferred, there are oscillations of two frequencies, neither of which have the same time period as the circuits.

Defendant’s apparatus in the present case is of the quenched-gap type, or impulse type, in which the frequency of the oscillations is determined by the energy taking up the same period as the natural time period of the secondary or antenna circuit, after it has been nonresonantly and quickly dumped from the primary circuit into the secondary circuit, while the only description of the apparatus in suit in the National Electric Signaling Co. case is that there was loose coupling between the two circuits admitting of resonance between these circuits, which necessarily implies a slow feeding of energy from a primary reservoir circuit oscillating at the same frequency to which the antenna circuit is tuned, which was the case in the Stone or Marconi open-gap type. In the later case of this plaintiff against the Kilbourne & Clark Manufacturing Co., 239 F. R. 328, two transmitters were considered in the court’s opinion, one known as the Simpson mercury valve transmitter, described at page 343 of the reported decision, and the other known as the “impulse” transmitter, described at page 348 of the reported decision. Both of these transmitters are fundamentally the same as defendant’s quenched-gap type in that they are based on the fundamental principle [fol. 830] of the Lodge impulse excitation set forth in Lodge’s 1898 patent; that is, the principle of quickly de-

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delivering the energy from the primary circuit into the antenna circuit nonresonantly and separating in effect the primary circuit from the secondary circuit once the delivery is complete, leaving the energy in the secondary circuit free to oscillate at the natural period of the secondary circuit uninfluenced by any maintained connection to the primary circuit. Referring to the Simpson type, Judge Net-erer states at page 346 of the reported decision as follows:

“The effect of this circuit upon the radiating circuit, as stated by Doctor Kolster, ‘is such as to get the energy into that radiating circuit very quickly, and to thereafter allow it to oscillate freely in its own natural way.’ This circuit has enormous decrement, and is nonpersistent. It is not, as in the Marconi patent in suit, primarily a reservoir or persistent oscillator, and does not cooperate with the antenna on the principle of resonance.”

This — precisely the same as the operation of defendant’s quenched-gap type of apparatus. In fact, the Simpson transmitter, as well as the impulse transmitter, were of the quenched-gap type, the decision covering this point at page 345, as follows:

“The quenched spark gap introduced into this country in 1908 by the Telefunken Co., of Germany, and now used upon all apparatus in suit, has added much to the efficiency of wireless apparatus. By it the character of the wave can be readily controlled, and the quality (the sharpness and purity) of the wave can be brought into harmony with the result desired, and the high-frequency generator impulse system will enable the operator to hitch ‘your (his) wagon to the earth and shake it, • • •’ and send messages to distant parts of the world, as stated by Pupin, *supra*.”

Thus the Kilbourne & Clark two types of apparatus both included improvements over the original Lodge disclosure of the principle of impulse excitation; that is, the use of a later developed type of spark gap which aided the effect desired by Lodge of removing the primary circuit from any maintained connection with the secondary circuit after the energy had been delivered to the secondary circuit.

The Simpson and impulse transmitter of Kilbourne & Clark did not provide for adjustment of the time period of the two circuits to control the point of production of the first beat, and for carrying this adjustment to that degree where the two circuits are out of accord in time period adjustment, the proper amount, to get a perfect beat or period of no current, which I have previously explained in detail. This adjustment is a second improvement over the original Lodge system, which permits of more perfectly obtaining the result desired by Lodge, that is, of quickly and certainly cutting off the primary circuit from a maintained connection with the secondary circuit. In every impulse type of transmitter there are several swings or oscillations of the energy at a double frequency before the first beat is reached where quenching can take place, and there seems to have been some contention on the part of the plaintiff in the Kilbourne & Clark case that this was sufficient to satisfy the requirements for persistent oscillations of the Marconi or Stone open gap type. At page 2598 of the record, in the case of *Marconi v. Kilbourne & Clark* Mr. Waterman, plaintiff's expert in that case, testified as follows:

[fol. 831] "The next statement is that it 'has enormous decrement.' Well the decrement was measured, Mr. Kolster measured it and found it to be about 0.5. The instrument did not read that far, but that is the estimate which he made—0.5. That means between 10 and 11 complete oscillations."

And again, at page 2691 of the record, Mr. Waterman testified as follows.

"With respect to the use of the term 'impulse,' if I have understood the defendant's witnesses correctly, the reason why this word 'impulse' is said to be properly applicable to the defendant's transmitter is because, due to this high ratio of capacity, this big condenser and single loop, and owing to this linear decrement, that is, variable spark-gap resistance, the number of oscillations in the primary circuit is small. Well, that number of oscillations was measured by Doctor Kolster on the steamship *Admiral Evans*, in the joint test, the decrement found to be substantially 0.5. Now, according to the ordinary formula, 0.5 means somewhere between 10 and 11 oscillations."

The testimony shows that the measured decrement referred to was that of the primary circuit of the Kilbourne & Clark type. Now, the Kilbourne & Clark type had tight coupling, which means that before quenching took place there were two coupling oscillations at different frequencies. Starting the number of oscillations based on a decrement measurement, as Mr. Waterman did, where there are two coupling oscillations instead of a single oscillation, is likely to lead into difficulty. For instance, Mr. Waterman states that there were somewhere between 10 and 11 oscillations, and there is nothing to show whether he meant 10 or 11 oscillations of each kind or a total of 10 or 11 of both kinds; for instance, six oscillations of the higher coupling frequency and five oscillations of the lower coupling frequency. He states, however, that his 10 or 11 oscillations are arrived at by applying the 0.5 decrement to the ordinary formula, which would lead to the belief that he was assuming a condition of one oscillation only, which is necessarily an incorrect assumption for a tight coupling arrangement such as was had in the Kilbourne & Clark apparatus. And even with the assumption of a one frequency condition, there would not result 10 or 11 oscillations, as stated by Mr. Waterman, where a decrement of 0.5 exists. For corroboration of my statement, in this matter, I refer to *Wireless Telegraphy*, by Zenneck, as translated by Seelig, 1915 edition, which I have many times previously referred to. Beginning page 390 of this publication, Zenneck gives a number of figures showing the oscillations had for different decrements, and in Figure 467, page 391, gives the plot for a decrement of 0.5. Now remembering that an oscillation represents a complete cycle, that is, a full swing above the line and a full swing below the line, as in Figure 467, it will be seen that there are not more than seven oscillations shown in the Zenneck figure.

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In defendant's quenched-gap type in the present case, there need be no cause for dispute as to the number of each [fol. 832] of the two coupling oscillations in the primary before quenching takes place and free oscillations in the antenna circuit begin, for this is a matter readily calculated from the formulæ which I have given at page 623 of the typewritten record mathematically expressing the relation of the two coupling frequencies to the degree of

coupling. A 20 per cent coupling is a good average value of coupling used in the quenched-gap transmitters of the defendant in this case, and at page 625 of the typewritten record I have shown that with such a degree of coupling, where the desired frequency is 1,000 kilocycles per second, there will be two coupling frequencies, one of about 1,112 kilocycles per second and the other of about 913 kilocycles per second; that is, that one coupling frequency is about four-fifths of the other coupling frequency. In other words, under such a condition of coupling with the two frequencies starting out together in the primary circuit after one has completed four oscillations, the other will have completed five oscillations, and the fifth oscillation of the second will be opposed to the fourth oscillation of the first to give the beat desired for quenching. This is all illustrated in my sketch O, illustrating the action in the quenched-gap system, and I make particular reference to my Figure 6*d*, where it can be easily followed that under conditions of two oscillations, where the frequency of one is four-fifths that of the other, they will be opposed at the fourth oscillation of one and the fifth oscillation of the other to give the desired beat. My Figure 6*a* of the same sketch shows that when this beat point is reached and quenching takes place in the primary circuit, there are no longer any oscillations in the primary circuit, but from this point on the real oscillations of the system begin, which are the free, single-frequency oscillations determined by the secondary or antenna circuit. Therefore, taking average conditions in apparatus of defendant in this case, there are four oscillations of the lower frequency and five of the higher frequency in the primary circuit.

Judge Netterer in his decision in the case of *Marconi v. Kilbourne & Clark*, disposed of this contention of the plaintiff that the double oscillations in the primary before quenching took place was sufficient to support the requirement in the Marconi patent of persistent oscillation, as follows, quoting from page 347 of the reported decision:

"And the further fact that it is shown that, as stated by Doctor Zenneck, 'there was only one system, the dummy antenna, and only one kind of oscillations, the free oscillation of the antenna'; and it further appears that oscillatory circuits are not necessarily tuned circuits, and good tuning is not possible with two and one-half waves in the train.' No

facts shown indicate that the oscillations were the result of resonant transfer of energy."

The expression "dummy antenna" is explained by the fact that the experiment referred to was of a laboratory nature and instead of using an elevated wire for an antenna, a laboratory circuit having the characteristics of an antenna was used, and such a circuit is known to the art as a "dummy antenna."

The quotation makes it clear that there was but one system involved in the useful oscillations, namely, the antenna, as contrasted to the Stone and Marconi plain-gap type, in which the oscillations originate in the primary circuit, travel across a linkage between the primary and secondary circuits as oscillations of one frequency, and then act in the [fol. 833] antenna circuit as oscillations of the frequency determined by the primary circuit.

The quotation then adds that the circuits are not necessarily tuned circuits, and I take this to mean that since the energy is not being transferred at the natural periods of the circuit, no advantages arise from tuning.

The quotation then makes it clear that even if an effort were made to take advantage of tuning to transfer energy, that no real advantage would be obtained because where the number of oscillations are few, such as two and one-half, good tuning is not possible on the principle brought out by the Lodge 1898 patent to the effect that it was necessary to have persistent oscillations for good tuning. The quotation does not mention the matter, but it must be remembered also that in addition to the oscillations being few in number they are also of two different frequencies not corresponding to the natural periods of the circuits, and under such circumstances it is impossible to in any wise consider a tuning relation between the circuits.

The quotation concludes as follows:

"No facts shown indicate that the oscillations were the result of resonant transfer of energy."

Thus Judge Netterer makes it clear that in the Marconi system or Stone system, where the oscillations of the desired frequency originate in and are determined by the primary circuit, they arrive in the antenna circuit for useful work as a result of a resonant transfer of energy between the two circuits, as contrasted to the quenched-gap system, in which

there can be no resonant transfer because the oscillations of the desired frequency do not come into being until the transfer has taken place and the primary circuit is quenched and eliminated from the system.

Judge Netterer also clearly showed that he did not consider that it made any material difference as to how many oscillations there were during the period of the transfer of the energy from the primary to the secondary circuit as long as the system was one resulting in quickly getting the energy into the antenna, where free oscillations were set up and determined by the antenna by quoting from Professor Ze-neck's testimony at the bottom of page 347 of the reported decision, as follows:

"From the standpoint of a physicist, therefore, and considering the result, it seems to me very immaterial whether the free oscillations start after one-half an oscillation or after two and one-half."

On page 350 of the reported decision, Judge Netterer held that the Kilbourne & Clark apparatus was identical with the apparatus of Figure 4 of the Lodge 1898 patent, and differentiated the Lodge system from the Marconi or Stone system as follows, quoting from page 350:

"Lodge does not use one circuit as a reservoir for the other, there being no resonant transfer of energy, the circuit in which the change originates being entirely separated when the radiating circuit is charged."

This statement as to the action of Lodge, which Judge Netterer says is the action of Kilbourne & Clark apparatus, is precisely the action of defendant's quenched-gap type in the present case. The quenched-gap type has no reservoir circuit, the primary circuit merely being a quick acting [fol. 834] charging or exciting circuit for the secondary. There is no resonant transfer of energy in the quenched-gap type, because (1) the energy is transferred at two frequencies entirely different from the frequencies to which the circuits are adjusted, (2) because the transfer of energy is too rapid to take any advantage of tuning were it possible in some way not yet known to the art to transfer the energy at but one frequency, and (3) the two circuits are not adjusted to have the same natural time period, but are out of adjustment to aid in getting the perfect beat necessary to good quenching action.

Judge Netterer further states on the same page as follows:

"For the purpose of furnishing a pure wave, Lodge provides that the energy undelivered to the radiating circuit be cut off, and states, on page 2 of his patent, that 'the advantage of this is the charges so communicated are left to oscillate free from any disturbance due to maintained connection with the source of electricity,' and the maximum effect will be produced on the receiving circuit."

This is precisely the operation sought and obtained in the quenched-gap type of apparatus. The quenched gap, due to its efficient quenching action, allows a tight coupling to quickly deliver the energy to the radiating circuit because when the beat is reached it will effectively deionize and withstand a powerful attempted reaction of the radiating circuit without breaking down, and this good quenching is further obtainable through adjusting the natural time periods of the two circuits to a difference that obtains a perfect or currentless beat, with the result that free oscillations in the antenna are obtained uninfluenced by any maintained connection with the primary circuit. Judge Netterer further states on the same page of the reported decision as follows:

"The operation of Lodge patent, Figure 4, is identical with defendant's in using impulse charging and variable inductance coil in the antenna. No reservoir circuit is used, and, when the radiating circuit is charged, it is entirely separated from the source of supply circuit which necessarily has some natural period."

This quotation describes precisely the quenched-gap type of apparatus in the present case. In all of the types there is found the Lodge variable-inductance coil in the antenna, and it is the adjustment of this Lodge variable-inductance coil that determines the frequency of the oscillations after all of the energy is delivered to the antenna and the primary circuit is out of action, just as did Lodge determine the frequency of his free oscillations in Figure 4 of his patent. The supply circuit or primary circuit in the quenched-gap type of apparatus has some natural period, just as did Lodge's primary or supply circuit and the primary of supply circuit of the Kilbourne & Clark apparatus. In the quenched-gap system, the natural period of the supply circuit is

adjusted to obtain a perfect beat or period of no current, but such adjustment results in the product of capacity and self-inductance being different from that of the product of capacity and self-inductance of the antenna circuit. This adjustment of the primary circuit has nothing whatever to do with the frequency of the radiated oscillations, this circuit being entirely out of action when these oscillations commence, and has nothing whatever to do with a resonant transfer of energy between the two circuits because the transfer takes place at two frequencies entirely different [fol. 835] from the time period adjustment of the circuit, and also because the time period adjustment of the primary circuit is different from that of the secondary circuit.

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Summarizing, it is my opinion that defendant's transmitting apparatus in the present case is entirely different from the apparatus considered in Judge Veeder's decision in the case of *Marconi v. National Electric Signaling Co.*, and is the same apparatus as that considered in Judge Netterer's decision in the case of *Marconi v. Kilbourne & Clark*.

Considering now defendant's receivers, I note that Judge Netterer held that the Kilbourne & Clark receiver was the same as the receiver shown in Figure 13 of the Lodge 1898 patent, the Kilbourne & Clark receiver having a tuned antenna circuit, as did the Lodge receiver, and a secondary circuit in which a detector was placed coupled to the tuned antenna circuit, the secondary circuit of Kilbourne & Clark not being arranged to vary the tuning to correspond to variations in the antenna circuit.

Some of the types of defendant's receivers in the present case are identical with the Kilbourne & Clark type of receiver, these being the Atlantic Communication Co. type and the Signal Corps pack set type, 1915, classified by me at page 803 of the typewritten record, and the Telefunken type and Foote-Pierson type, classified by me at page 811 of the typewritten record. At page 805 of the typewritten record, I have referred to the Signal Corps pack set type as having not only an untuned secondary circuit, but also including a coupling between the two circuits consisting of a small condenser. In respect to the matter of an untuned secondary circuit, it corresponds exactly with the Lodge patent. In respect to the matter

of a coupling, it is absolutely unlike both the Lodge patent and the Marconi patent under consideration.

The other types of receivers of defendant in the present case only differ from the Kilbourne & Clark type in having a variable condenser in the secondary circuit, which is the variable condenser of Figure 1 of Marconi patent 627650 of 1899, this being the condenser K, as illustrated in my sketch M, opposite page 701 of the type-written record. The Marconi patent in suit provides for varying the inductance in the secondary circuit for the precise adjustment of the two circuits to have the same natural time period, but defendant's apparatus employs the variable condenser K of the earlier Marconi patent for this purpose. In defendant's type of apparatus the inductance is not changed for the purpose of precise adjustment, but arrangements are made for varying the inductance in large steps for the purpose of making the receivers useful over a wide range of frequencies, this being done in a number of ways, such as entirely removing one coil having a certain number of turns and replacing by another coil having a different number of turns, or by a series of space contacts on the winding of a coil of large extent. For instance, it is not in the practice of defendant to build a receiver to cover the range of 30 kilocycles to 300 kilocycles, in as many as 10 steps, requiring 10 different coils for insertion in the receiver, or 10 different contacts. With one coil in place, the range would be, for instance, from 30 kilocycles to 50 kilocycles. With the next coil in place, the range would be from 40 kilocycles to 60 kilocycles, and so on with each range provided by the coils overlapping somewhat. With a particular coil in place, no effort is made to obtain the precise adjustment necessary for tuning, this always being done with the variable condenser of the Marconi 1899 patent. Either method of accomplishing the tuning was adequately provided for by the prior art and particularly in the Stone to Baker 1899 letters and the Stone patents.

The receiver shown in plaintiff's Exhibit 105, by Mr. Waterman, as being the receiver in the case of *Marconi v. National Electric Signaling Co.*, differs from the Kilbourne & Clark type and those types of defendant that I have just referred to as having untuned secondaries in that the National Electric signaling system had a tuned secondary. It differs from those types of defendant in the present case

having tuned secondaries in that the arrangement for precise adjustment is through the variation of inductance, as illustrated in the Marconi patent, instead of the variation of capacity as provided for in the Marconi 1899 patent, and employed in defendant's types of apparatus in the present case.

However, Stone made provision for the particular type of adjustment shown in the National Electric Signaling Co. apparatus, that of varying the inductance, in his patent 714756, previously referred to by me, at page 6, commencing line 75 of the specification, where he states:

"In both the organizations illustrated in figures 5 and 6 the inductance coils L may be made adjustable and serve as a means whereby the operators may adjust the apparatus to the particular frequency which it is intended to employ."

Summarizing, it is my opinion that those types of apparatus of defendant in the present case having untuned secondary circuits are precisely the same as the Kilbourne & Clark type of apparatus held by Judge Netterer not to infringe, and are different from the National Electric Signaling Co. type. That the types of apparatus having tuned secondary circuits only differ from the Kilbourne & Clark type in that they employ the variable condenser K of Figure 1 of the Marconi 1899 patent, and differ from the National Electric Signaling Co. type in that they do employ the variable condenser instead of the variable inductance shown by the Marconi patent in suit, but which was provided for by Stone, as quoted above.

Defendant's counsel offer in evidence the following exhibits referred to in the deposition of this witness:

Defendant's Exhibit Z-4. Page 58 of Navy Manual of 1915.

Defendant's Exhibit A-5. Loftin Sketch P.

Defendant's Exhibit B-5. Pages 332 and 333 of the Electrician, of London, published June 11, 1909.

Defendant's Exhibit C-5. Pages 171 to 175, inclusive, of the London Electrician, published November 10, 1911.

Defendant's Exhibit D-5. Pages 87 to 97 and 390 to 391 of Wireless Telegraphy, by Zenneck, published in 1915.

Defendant's Exhibit E-5. Pages 199 to 200 of Wireless Telegraphy and Telephony, by Eccles, published in London, England, 1918.

Defendant's Exhibit F-5. Pages 377 to 378 of *Principles Underlying Radio Communication*, published at Washington, 1922.

[fol. 837] Defendant's Exhibit G-5. Preface and pages 9, 17, 55 to 59 of *Wireless Telegraphy*, by Leggett, published at New York, 1921.

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38. Question. What effect did the act of August 13, 1912, to which you have already referred, have upon the system described in the Marconi patent 763772 and upon the quenched-gap system, respectively?

Answer. The act of August 13, 1912, under section 3, contains a number of regulations governing the character of waves permissibly emitted by radio transmitters, and the third and fourth regulations affect the manner in which the Marconi or Stone open-gap type can be used, these regulations reading as follows:

"Third. At all stations if the sending apparatus, to be referred to hereinafter as the 'transmitter,' is of such a character that the energy is radiated in two or more wave lengths, more or less sharply defined, as indicated by a sensitive wave meter, the energy in no one of the lesser waves shall exceed 10 per cent of that in the greatest."

"Fourth. At all stations the logarithmic decrement per complete oscillation in the wave trains emitted by the transmitter shall not exceed two-tenths except when sending distress signals or signals and messages relating thereto."

Referring to the first regulation, I do not know of any manner in which the plain-gap type of transmitter can be adjusted when sufficiently tightly coupled to cause the energy in one of the coupling waves to be not more than 10 per cent of the energy in the other coupling wave. Referring to my sketch G, Figure 2b, I have shown the two coupling waves practically in their relative proportions in the manner of strength of signals. It generally happens that the wave at the higher frequency, which I show in red in the sketch, is slightly stronger than the wave at the lower frequency, which I show in green in the sketch. But the difference is only a few percent and never approaches the 90 percent difference required by the first quoted regulation.

Therefore, to comply with the regulation it is necessary to employ a coupling between the primary and secondary circuits of the transmitter that in effect but a single wave

is radiated, as I have illustrated in Figure 5b of my sketch H. The result of the use of such a loose coupling is the transfer of but a very small percentage of the total energy available in the primary circuit to the secondary or antenna circuit, very seriously reducing the overall efficiency of the transmitter.

The quenched-gap type of transmitter is capable of complying with the first quoted regulation when a very tight coupling between the primary and secondary circuits is used. Referring to my sketch O, Figure 6b, it is seen that waves are radiated at three different frequencies, two of them being due to the two coupling frequencies which exist while the energy is being quickly transferred from the primary to the antenna circuit, which I have illustrated in green, the lower frequency, and in red, the higher frequency, [fol. 838] in the sketch. The third frequency is the desired signaling frequency, and I have illustrated this in purple in the sketch. The two coupling frequencies exist for such a short period of time that in practice the energy in them as indicated by a sensitive wave meter is less than 10 per cent of the energy in the desired frequency, as required by the regulation.

Thus, the quenched-gap type can use a very tight coupling resulting in a quick and efficient transfer of energy from the source to the antenna circuit, where the energy is efficiently used for useful radiation of signals, and at the same time complies with the law.

The second quoted regulation definitely fixes the decrement permissible for a transmitter, and the decrement referred to is merely a measure of the sharpness of the tune, or referring to my sketch O, Figure 6b, the peakedness or pointedness of the signaling wave. The narrow or more pointed the curve of frequency, such as the purple curve in the figure, the more sharply can a receiver be tuned to the signaling wave without interference from other sharp signaling waves, and this simply means that the decrement is low. And the regulation has set this decrement not to exceed 0.2. The decrement or sharpness of the wave is determined by the number of oscillations in the train—the more the number of oscillations in the train the less is the decrement or the sharper the wave. For instance, in Figure 6a of my sketch O, where I have shown the oscillations in the antenna circuit of a quenched-gap system, it is seen that the purple oscillations which come into being after

all the energy has been transferred to the antenna circuit exist for a long time, this being on account of a large amount of energy being transferred and suffering only very small wasteful dissipation in the antenna circuit, nearly all being usefully employed in radiation. Therefore the quenched-gap system easily complies with the law in not exceeding the 0.2 decrement allowed, and at the same time is extremely efficient in the handling of electrical energy.

In the plain-gap type, if the two circuits are closely coupled, there results two signaling waves as illustrated in Figure 2b of my sketch G, and since the energy is transferred from one circuit to another and encounters large losses in the primary circuit where there is a spark gap, the oscillations will not endure for a long time, and in practice it is found that they die out so quickly that neither one of the curves shown in Figure 2b will be sufficiently sharp or peaked to give the 0.2 decrement required by law. If the coupling is loosened to some point between what is generally known as "loose coupling" and the tight coupling permissible with the quenched-gap type, the two coupling frequencies come close together, so that the decrement can not be measured for each of the curves separately, but must be measured as if the two curves are but one, which results in obtaining a very high decrement in no wise within the limits set by the law. The result is that in the open-gap type a coupling sufficiently loose must be used that for all practical purposes there is but a single frequency such as I have illustrated in Figure 5b of my sketch H. When this is done the plain-gap type will come within the sharpness or decrement fixed by law, but under such loose coupling the transfer of energy from the primary to the antenna circuit is so inefficient that there results a very low overall efficiency for this type of transmitter.

[fol. 839] Summarizing, while it is possible to adjust the Marconi or Stone plain-gap type of transmitter so that it gives a wave sufficiently sharp and pure to meet the requirements of the law, this is only accomplished through a tremendous sacrifice in overall efficiency, with the result that the quenched-gap type which easily complies with the law under adjustment that permits of high overall efficiency entirely displaced the plain gap-type in commercial use as soon as the quenched-gap type became a commercial design.

39. Question. Please state the relative extent of use of

the two-electrode and three-electrode vacuum tubes in the wireless art, both in commercial practice and in governmental use?

Answer. I have been more or less intimately associated with radio practice for the past 14 years and have never encountered a two-electrode vacuum tube in use anywhere. I am thoroughly acquainted with radio practice in the United States and know that no use is or has been made of the two-electrode vacuum tube in radio. I have visited most of the important radio stations in Europe and most of the important radio manufacturing plants and laboratories, and am acquainted with many of the prominent workers in radio in Europe and have conferred with them in numerous ways from time to time, and have never encountered a single trace of a two-electrode vacuum tube being placed in practical use. I have read a large part of the literature of the world on the subject of radio and do not recall a single reference to the practical use of the two-electrode tube. I have recently made a complete survey of all of the radio apparatus bought by the Army and Navy since 1910, and so far as I can find these services have come into the possession of but a very small number of two-electrode tubes, and these only in connection with one purchase of apparatus in which the vacuum tube did not form a vital part, and the tube was not specified in the purchase. The purchase I refer to was one by the Navy in which the Marconi Wireless Telegraph Co. of America furnished a few devices known as the Bellini-Tosi direction finder, on which occasion the Marconi Co. supplied a small number of two-electrode vacuum tubes to be used as detectors with these devices. I personally experimented with one of these direction finders in 1912 or 1913, and did not use the two-electrode tube as a detector, but a crystal detector.

On the other hand the three-electrode vacuum tube has been in extensive use throughout the world ever since it became a commercially available article. I have seen its actual use in all of the important radio stations that I have visited, as previously referred to, and know of its large manufacture in plants in Europe which I have visited, as well as in this country. From my survey of the purchases of radio apparatus by the Army and the Navy since 1910 I know that both of these services have bought three-electrode

vacuum tubes in very large numbers ever since it became commercially available. I am familiar with practically all of the circuit arrangements which have been used by both the Army and Navy in radio apparatus for many years, and know that in all arrangements wherein vacuum tubes are used, that they are specifically designed for the use of three-electrode vacuum tubes instead of two-electrode tubes, and the difference is readily apparent to one skilled in the art, as a circuit for use with a two-electrode tube would be characteristically different from a circuit for use with a three-electrode tube.

[fol. 840] The three-electrode vacuum tube is now being extensively manufactured in small sizes for radio receiving and in large sizes for radio transmitters, the present tendency of the art being to discard the quenched-gap type of radio transmitter which has been so popular for ships and other uses requiring small and intermediate power transmitters for a more recent design of radio transmitter employing three-electrode vacuum tubes as the oscillation generator.

During the present-day popularity of radio broadcasting, the three-electrode vacuum tube is a household article, being manufactured and sold by the million through small shops located in large numbers throughout the country, and in all of this activity it is almost impossible to find a two-electrode vacuum tube for sale. In fact there is no such thing as a comparison of the extent of uses of the two devices. The two-electrode vacuum tube simply has not been used, while the three-electrode vacuum tube has found use so extensive that the extent is simply a matter of conjecture.

(Direct examination closed.)

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Cross-examination by Mr. Betts.

40. Cross-question. In your answer to question 1, you stated that you were assigned in 1919 to what was known as the Interdepartmental Radio Board, of which you were elected chairman. Who assigned you to this duty and who were the other members of the board?

Answer. As I recall it I was assigned as a member of the board in a letter from the Secretary of the Navy to the Attorney General, being merely furnished with a copy of

the letter and not given any definite written orders for the duty. I was elected chairman of the board by the members of the board. The other members were Harry E. Knight, Esq., representing the Department of Justice, who relieved H. C. Workman, Esq., who represented the Department of Justice for a very short period of time; R. H. Young, Esq., and Capt. Guy Hill, United States Army, representing the War Department and Commander S. C. Hooper, representing the Navy Department.

41. Cross-question. How long did this board exist?

Answer. About two years and a half, in completing the task set for it, but so far as I know, it has never been officially dissolved.

42. Cross-question. Prior to your giving your present deposition, and while you were active as a member of the interdepartmental board, did you as a part of your study of the art of radio research and development examine the record in the following mentioned cases:

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Marconi Wireless Telegraph Co. of America *v.* National Electric Signaling Co., United States District Court, Eastern District of New York, on Marconi patent 11913, Lodge 609154, Marconi 763772, decided by Judge Veeder; Marconi Wireless Telegraph Co. of America *v.* Atlantic Communication Co., United States District Court, Eastern District of New York, Marconi patent 763772, on motion for preliminary injunction before Veeder, J.; Marconi Wireless Telegraph Co. of America *v.* Kilbourne & Clark Manufacturing Co., United States District Court, Western District of Washington, Marconi Patent 763772; Marconi Wireless Telegraph Co. of America *v.* De Forest Wireless Telegraph & Telephone Co. on Fleming patent, the foregoing patents being the patents in suit, and did you familiarize yourself with the prior art as set forth in those cases?

Answer. In connection with my duties with the Interdepartmental Radio Board I examined during the two years and a half in which the board was active an enormous amount of literature of various kinds, including records involving litigation of patents before the board. I do not recall definitely any of the particular records examined, but such records as were examined were in some way included in the files of the board, which are now, to the best of my knowledge and belief, in the custody of the Navy

Department. Since my duties in connection with the board were performed as an officer of the Navy, I do not feel at liberty to discuss in detail those matters which are a part of the files of the Navy Department without the department's consent.

43. Cross-question. Don't you remember, Commander, the fact that at the time you were serving as a member of the interdepartmental board claimant's counsel submitted to you copies of the record in the cases listed in the last question?

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Answer. I recall that numerous claimants before the board submitted records of various kinds, including records involving prior litigation, and that claimants' counsel was among those who submitted such records. And I also recall that after the completion of the board's active work I made special effort to return those records which had been loaned the board for temporary use only.

44. Cross-question. Please answer the question which is limited to the records of the specific cases mentioned.

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Answer. The only record of those listed in the question that I definitely recall is that of the Kilbourne & Clark case, which, as I recall it, was secured from the Kilbourne & Clark Co. I do not definitely recall any of the other records listed.

45. Cross-question. The interdepartmental board of which you were chairman made a report, did it not, with reference [fol. 842] spect to the present claimant's claim under the Marconi patent 763773, and Fleming patent 803684, and you signed that report as its chairman.

Answer. The board upon the completion of its work made a report which, so far as I know, has never been released for public consideration, and in the absence of any definite authority from the Navy Department, which I represented on the board, I do not consider that I am at liberty to discuss the results of the board's work.

46. Cross-question. I did not ask you to discuss any report, but whether the report was made by the interdepartmental board, and whether you signed such a report as its chairman?

Answer. I have not consulted the Navy Department concerning its willingness as to the extent that I may discuss

the operations of the Interdepartmental Radio Board since my resignation in March just past, but do know that up to the time of my resignation, it was unwilling to have the operations of that board open to the public disclosure, and therefore, do not feel at liberty to discuss in my testimony, the particular form of the report or such other details as the question involves.

47. Cross-question. Do you decline to state whether or not the interdepartmental board of which you were chairman made a report touching the claim of the present plaintiff upon the patents discussed in your direct examination?

Answer. In the absence of the express consent of the Navy Department, I do.

48. Cross-examination. Do you decline to state whether or not you signed a report as chairman of the interdepartmental board, touching the claim of the present plaintiff upon the Lodge patent involved in this suit?

Answer. In the absence of the express consent of the Navy Department, I do.

49. Cross-question. Will you state whether or not prior to October 1, 1920, you were aware of the fact that suits had been brought by the Marconi Wireless Telegraph Co. of America against National Electric Signaling Co. in United States District Court in the Eastern District of New York; against De Forest Wireless Telegraph & Telephone Co. on the Fleming patent in suit; against the Kilbourne & Clark Manufacturing Co. upon Marconi patent 763772; against the Atlantic Communication Co. upon Marconi patent 763772?

[fol. 843] Answer. I have been for some time aware of most of the litigation referred to and believe that my knowledge was acquired prior to October 1, 1920.

50. Cross-question. Prior to October 1, 1920, had you examined and were you familiar with the record in the following cases:

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Marconi Wireless Telegraph Co. of America *v.* National Electric Signal Co. on Marconi patent 11913, Lodge patent 609154, Marconi patent 763772 (Veeder, J.)

Marconi Wireless Telegraph Co. of America *v.* Atlantic Communication Co. Motion for preliminary injunction before Veeder, J.

Marconi Wireless Telegraph Co. of America v. Kilbourne & Clark Manufacturing Co. on Marconi patent 763772.

Marconi Wireless Telegraph Co. v. De Forest Wireless Telegraph & Telephone Co. on Fleming patent?

Answer. My knowledge of the litigation in question was acquired from both examination of records and discussion with others, many of whom were principals in the litigation, and I think I had some familiarity with most of the litigation in question prior to October 1, 1920.

51. Cross-question. Since you say you were aware of the foregoing litigation, prior to October 1, 1920, do you not conceive that it was part of your duty representing the Navy Department on the interdepartmental board at this time to thoroughly examine and familiarize yourself with the litigation listed in my cross-question 49?

Answer. I had other duties in addition to my duty as a member of the board, and was but one of five members on the board. I took my share of the work of the board to the best of my ability, but the task was enormous and it would have been impossible for any one member to consider every claim in every phase that was presented in detail.

52. Cross-question. Please answer the specific question I put to you in cross-question 51?

Answer. No; I do not consider that it was my undivided duty to thoroughly examine and familiarize myself with all of the litigation listed in your cross-question 49.

53. Cross-question. I did not ask about your "undivided" duty. Will you please limit your answer to the question propounded? You have stated in your direct examination that you were elected in 1919 chairman of the Interdepartmental Radio Board. You have also stated that prior to October 1, 1920, you were familiar with the litigation listed in cross-question 50. Do you not conceive that it was your duty, representing the United States on this interdepartmental board with respect to a claim of the present plaintiff against the United States for infringement of letters patent which had been involved in this prior litigation.

to examine the records in this prior litigation, and to thoroughly familiarize yourself with what was set up in the prior art in those cases, and did you not so do?

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[fol. 844] Answer. In the absence of the express consent of the Navy Department, I do not feel at liberty to discuss the procedure of the board in connection with the consideration of the claims of any of the claimants that appeared before the board.

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54. Cross-question. (Question repeated.)

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Answer. Each and every claim presented to the board was considered as carefully as it was humanly possible to do so with the facilities at the disposition of the board and in a reasonable period of time. I have stated that the board made a report to the proper officials in connection with the work assigned the board, but since it was my definite knowledge that the Navy Department was not willing to disclose the proceedings of the board up to the time that I resigned from the Navy, and since I have not been instructed to the contrary since my resignation, I must decline to answer questions as to the procedure of the board, unless the court instructs otherwise.

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55. Cross-question. I am not now asking you questions as to the procedure of the board. My question is a personal one, namely, as to what you personally did or did not do at the time inquired about in Cross-question 53 with respect to the records in the litigations listed in cross-question 50?

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Answer. I was a member of the board as an official in the Navy Department, and I do not understand that my personal acts in connection with that duty can be separated from the official capacity in which I acted.

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56. Cross-question. I understand, then, that you decline to state whether you examined and thoroughly familiarized

yourself personally with the records in the litigations listed in cross-question 50?

Answer. I do.

57. Cross-question. Are you now familiar with the records of the litigations listed in cross-question 50?

Answer. I am to varying degrees in the several cases.

58. Cross-question. When first did you begin to study these records?

Answer. In 1919.

[fol. 845] 59. Cross-question. Can you refer to a single patent or publication or prior-art device which you have referred to in your direct examination in the present case which was not involved in the litigations listed in cross-question 50?

Answer. I have referred to an extremely large number of publications and patents, but, limiting the consideration to the prior art, I do not recall that I have referred to any which was not in one case or another in the prior litigations brought out, though I should like to reserve opportunity for correcting this statement in case a detailed examination should show that I have used other art.

Mr. Betts. Certainly, up to the time that the present deposition is closed.

60. Cross-question. Referring to Marconi patent 763772, is there any particular kind of spark gap illustrated and described in the specification; that is to say, is what you have called the open gap or the rotary gap or the quenched gap specifically illustrated and described in the patent as the form of gap which is to be employed? Please quote all portions of the specification which describe such form of gap and point to the figures of the drawings which illustrate the form of gap.

Answer. Figure 1 of the patent quite definitely illustrates a form of gap known to the art as an open gap, this being the device *c* in the figure comprising two spherical electrodes illustrated by the two small circles somewhat separated, and the figure does not illustrate any inclosing arrangement for these electrodes. The language of the specification does not definitely specify any form of spark gap, nor does the particular mode of operation of the

Marconi patent require any particular form of gap except a preferred form flows out of the requirements for "best results" set up in several places in the specification. At page 2, lines 12 to 20, Marconi states:

"My experiments have demonstrated that the best results are obtained at the transmitting station when I use a persistent oscillator—an electrical circuit of such a character that if electromotive force is suddenly applied to it and the current then cut off, electrical oscillations are set up in the circuit which persists or are maintained for a long time—in the primary circuit * * *."

To obtain "best results" in the matter of persistent oscillations or oscillations that are maintained for a long time in the primary circuit, the open type of gap satisfies the Marconi system much better than the quenched-gap type or rotary type.

61. Cross-question. Referring to Loftin sketch A, what figure of what patent or publication do you find sets forth the apparatus of Loftin sketch A?

Answer. The high-frequency oscillation generator system illustrated has all of the circuits included from the primary P of the two-winding transformer $p s^1$ and to the left in the second system to the left in Figure 165 of the book entitled "Inventions, Researches, and Writings of Nikola Tesla," by Martin, published in 1894. The Tesla book describes various applications to which the high-frequency current produced by the systems illustrated in Figure 165 may be put, and on page 346 definitely proposes the production of electric waves by such currents for the transmission of telegraph messages without wires. On page 348, in connection with Figure 185, the book proposes an electric wave producing system for association with a source of high-frequency currents, comprising an elevated conductor surface connected to one end of the terminals of the source, such as that illustrated in Figure 165, the other terminal of the source being connected to the earth or water main presumably buried in the earth. My figure in Loftin sketch A simply pictorially illustrates such a connection.

62. Cross-question. I understand, then, from your last answer that your Loftin sketch A, Tesla transmitter, is a combination of what you say is shown in Figure 165 of Tesla's book of 1894, and what is shown in Figure 185, is that right?

Answer. Figure 185 of the Tesla book illustrates diagrammatically a complete system, it being understood from the text that the source of high-frequency oscillations illustrated as associated with the antenna circuit is any one of the numerous sources illustrated in Figure 165 of the book. My sketch simply adds the details of such a high-frequency source omitted by the Tesla book in Figure 185, because the book had provided the details in the earlier pages.

63. Cross-question. So you answer my question in the affirmative?

Answer. Yes.

64. Cross-question. Where do you find the transformer P S¹ of Loftin sketch A to be suggested by Tesla as a part of the organization of either Figure 165 or Figure 185 of the Tesla, 1894, book?

Answer. In Figure 165, the second system from the left, includes a two-winding transformer having a primary P and a secondary winding S¹. This system is a source of high-frequency oscillations to which any work circuit, such as a radio antenna, can be connected, the two terminals for connection to the work circuit being illustrated as the wires leading away from the end of the secondary S¹.

65. Cross-question. Figure 165 of the Tesla, 1894 book does not purport to illustrate, does it, a radio or wireless system?

Answer. Figure 165 has all the essentials of a wireless system. • • • The figure has all the inherent capabilities of transmitting electrical energy through space and therefore purports to do what it is inherently capable of.

66. Cross-question. In what figure of the Tesla, 1894, book do you find illustrated as a part of a radio telegraph system a transformer such as that which you have illustrated at P S' in Loftin sketch A, Tesla transmitter?

Answer. In Figure 165.

67. Cross-question. Do you mean to say, Commander, that Figure 165 illustrates a radio telegraph system?

Answer. It does.

68. Cross-question. In what figure of the defendant's Exhibit F-4 do you find illustrated the apparatus which you have exhibited in "Loftin sketch B, Popoff receiver"?

Answer. Figure 2 of defendant's Exhibit F-4 illustrates in detail the coherer and the appurtenances for making it

an effective detector of electrical impulses. Commencing with the last paragraph, page 15, of the exhibit, there is a complete description of the manner in which the coherer is to be used when the electrical impulses arrive through space, which description provides for the use of an elevated [fol. 847] conductor connected to one end of Figure 2 and a ground connection to the other end of Figure 2. My sketch B reproduces Figure 2 merely pictorially, illustrating the elevated conductor and ground connection provided for in the text.

69. Cross-question. Referring to your Loftin sketch A, Tesla transmitter, what have you intended to illustrate by the part lettered *dd dd*?

Answer. These illustrate spark gaps or devices referred to in the Marconi patents in suit as "spark producers."

70. Cross-question. Where do you find in the Tesla, 1894, book, either in Figure 165 or Figure 185, spark gaps or "spark producers" such as you have illustrated in Loftin sketch A, Tesla transmitter?

Answer. Such devices are illustrated in all six of the organizations shown in Figure 165 of the Tesla book, being uniformly referred to throughout the organization by the reference letters *d d*. In the particular figure or organization which I have copied, namely, the second from the left, the spark producer is shown as having either of two positions, one in series with the condenser and inductance of the oscillatory circuit, and the other in parallel with these elements, this position being represented by the broken-line structure in the figure.

71. Cross-question. Do I understand you to say that the parts marked *d d* in Figure 165 of the Tesla, 1894, book were used for the purpose of acting as spark producers in a radio or wireless telegraph system?

Answer. They were.

72. Cross-question. In your direct examination you have, I believe, referred to coupling as being loose and coupling as being tight. What degree of coupling do you include in each of these phrases?

Answer. In my testimony I stated that a coupling would be considered tight when it caused a double frequency sufficiently widely separated as to be detectable with practical receiving apparatus; that is, an operator provided with an ordinary receiver would be able to tune his apparatus to

two definite points in which he would find a maximum strength of signal. For instance, if the assigned frequency for the transmitting station is 1,000 kilocycles, and if the operator sets his receiver at this point and does not find the signal, or finds it with the signal very weak, but by tuning to 1,050 kilocycles and 950 kilocycles, he finds signals stronger than at 1,000 kilocycles, tight coupling may be said to exist, as far as radio communication systems are concerned. On the other hand, if the assigned frequency to the transmitting station is 1,000 kilocycles and the operator finds the maximum signal strength at this point, and by tuning to other frequencies finds that the signal gradually grows weaker, loose coupling may be said to exist. In radio practice couplings are used in the neighborhood of 20 per cent for quenched-gap systems, which if used in the open gap of Marconi system would give two frequencies located at about 1,100 and 900 kilocycles if the assigned frequency is 1,000 kilocycles. In the open-gap type of system, when the coupling is loosened to the neighborhood of 3 per cent, it is found in practice that ordinary receiving apparatus will detect but one frequency, and in [fol. 848] practical operation such a coupling is commonly known as loose, though couplings less than 3 per cent are sometimes employed for extreme selectivity.

73. Cross-question. Irrespective of the form of spark gap employed in a two-circuit transmitter, what degree of coupling between the transformer coils would you designate as loose couplings and what degree of coupling would you designate as tight couplings between such coils?

Answer. I would designate any coupling that with practical receiving apparatus gives a detectable double hump as a tight coupling. In the Marconi system such conditions arise in going from 3 per cent up.

74. Cross-question. In the Marconi patent 763772 there is illustrated and described several different transformers for coupling the two transmitter circuits together. Is that not so?

Answer. Yes.

75. Cross-question. Have you ever personally built or had built under your supervision any of the transformers disclosed in the Marconi patent 763772 for coupling the two transmitter circuits together?

Answer. No.

76. Cross-question. So you do not know the percentage or degree of coupling between the coils of the two-circuit transformers disclosed in the Marconi patent 763772?

Answer. No one does. The structure of a transformer is not a measure of the coupling that it will create between two circuits. The coupling is a function not only of the two parts of the two systems which are interlinked, but of the remainder of the system in which the coupling elements are included. A coupling coil which might give a very loose coupling in interlinking two circuits because of other characteristics of the two circuits might give a very tight coupling under other arrangements of circuits. Merely to know the structure of a transformer in no way decides what the coupling between the two circuits will be when the transformer is put into use.

77. Cross-question. What are the other characteristics of the two circuits besides the degree of coupling between the structure of the transformer which determines the degree of couplings between the circuits? I am not referring to physical pieces of apparatus.

Answer. I have clearly illustrated the effect of other features of the circuit on the degree of coupling in Figure 5 of my sketch F. In that figure I have shown a coupling transformer comprising the coils d and d' , which are closely related so as to have their magnetic fields interlinking. I have also shown in the two circuits inductance coils g^1 and g . In developing this figure, I have explained that the total energy of the oscillatory currents in the system is distributed over the coils of the system in proportion to the number of turns or inductance of the coils. Referring to the figure and, considering the primary circuit, if there are more coils in g^1 than in d , it is apparent that there will be more energy in the coil g^1 than in the coil d , which I have illustrated by making the lines or circles of magnetic force of greater extent for the coil g^1 than for the coil d . Now, if the coil d is the only one closely related to the secondary circuit and has only a small fraction of the energy of the primary circuit, it is apparent that it can only transfer a small amount of the energy of the primary circuit to the secondary circuit, no matter how closely the two coils of [fol. 849] the coupling transformer are related. Reducing this to actual physical apparatus, if we insert in the coupled circuits large coils in addition to the coils involved in the

inductance we may reduce what might ordinarily be a coupling transformer for tight coupling to a very loosely coupled system. This matter is considered in detail in the patent to John Stone Stone, 714756, the application for which was filed on February 8, 1900, prior to the Marconi application for the patent now in suit.

78. Cross question: In the course of your study prior to October 1, 1920, of the art of radio or wireless telegraphy, and of its development, did you read and are you familiar with the judgment of Mr. Justice Parker in the suit of Marconi et al. v. The British Radio Telegraph & Telephone Co. (Ltd.) on British Marconi patent 7777?

Answer. I may have; I do not recall definitely.

79. Cross-question. Do you remember ever having read and examined this judgment?

Answer. I do not recall.

80. Cross-question. Do you recall reading or examining the judgment of Mr. Justice Eve in the suit of G. Marconi and Marconi Wireless Telegraph Co. (Ltd.) v. The Helsby Wireless Telegraph Co. (Ltd.), dated July 24, 1914, in the high court of justice, chancery division, on Marconi patent 7777?

Answer. I recall having examined in a superficial way some records in the matter of litigation in the British courts involving the Marconi patent, but nothing definite occurs to me at this time as to my impressions from such examination.

81. Cross-question. You are at least aware of the fact that the Marconi British patent 7777 of 1900, to which I have referred, is the so-called corresponding British patent to the American Marconi patent 763772, in suit?

Answer. That is my understanding.

82. Cross-question. In what patent or publication granted or published prior to November 10, 1900, do you find illustrated and disclosed a radio or wireless telegraph transmitter composed of an open or radiating circuit coupled to a closed circuit which includes a spark producer, the two circuits being tuned together?

Answer. There has been such a lax use and general misunderstanding as to the meaning of the term "tuned" in the electrical art as well as that application of the electrical art having to do with electrical communication, commonly termed wireless or radiotelegraphy, that before answering

your question I would be pleased to understand in just what sense the expression is employed in the question.

83. Cross-question. You may answer the question giving your own interpretation of the word "tuned" in your answer.

Answer. In my direct testimony I have explained that tuning in its correct sense is not obtained through a mere adjustment of the time periods of the two circuits to be the same, where coupling exists between the circuits having their time period so adjusted any more than would two stretched strings be in tune if after carefully adjusting their tension they were tied together by a third string, unless the linking of the two systems, either electrical or mechanical in the case of the stretched string, is sufficiently loose in practice not to noticeably interfere with the individual action of each of the units of the system. The Marconi patent named in the question very specifically [fol. 850] points out the precise adjustment of the time periods of the two circuits. Without qualifying the specific specification the arrangement is found in Tesla patent 645576, of March 20, 1900.

84. Cross-question. Is that the only instance of which you now know of?

Answer. It is also found in great detail in the Stone patent 714756, the application for which was filed February 8, 1900. There is, of course, no difference between the principles of the transfer of energy at a transmitting station and the transfer of energy from one circuit to another at a receiving station, and the principle of tuning two circuits together at a receiving station was definitely set up in Marconi patent 627650.

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85. Cross-question. Is the Tesla patent No. 645576, published March 20, 1900, the only patent or publication which you know of at the present time which complies with my cross-question 82?

Answer. Limiting the matter to the transmitting end of an electrical communication system, and giving the matter of tuning the meaning which I have myself outlined, the Tesla patent is the only one that I now recall that was published prior to the date in question.

86. Cross-question. What other meaning of the word tuning is there than the one that you have outlined?

Answer. Tuning, or, as sometimes termed, resonance, is a very precise and definite physical phenomena in which a responding system is capable of responding with the least resistance to a periodic impressed or applied force.

87. Cross-question. Giving the word tuning any of the meanings which you have done in your answers to cross-questions 83 and 86, is the Tesla patent 645576, the only patent or publication which you know of at the present time which complies with my cross question 82?

Answer. Still limiting the consideration to the mere transfer of energy between two circuits at a radio transmitter the Tesla patent is the only one which complies with the specific adjustment condition set up in the Marconi patent, which I stated necessarily did not imply any use of tuning in its true sense, but does comply with the physical adjustments provided for in the Marconi patent.

88. Cross-question. Yesterday you declined to answer certain cross questions (such as cross-question 47, 48, 53, 56), giving as a reason therefore absence of express consent of the Navy Department. Since you have resigned from the Navy, do you think that you can decline to answer the questions in a court of justice regarding matters to which [fol. 851] you have referred to on your direct examination here without some unnamed official of the Navy Department O. King or giving his consent to the scope and character of your testimony?

Answer. I do not recall any instances in my direct testimony where I touched upon matters of procedure during the activities of the Interdepartmental Radio Board.

89. Cross-question. In answer to question 20 in your direct examination, you referred to some drawings of the Bureau of Equipment of the Navy Department of various dates. Did you obtain the express consent of the Navy Department to refer to these drawings in this case?

Answer. The list of drawings to which I referred in answer to question 20 are included in defendant's Exhibit L-2, which is a number of drawings certified to as being parts of the files of the Bureau of Engineering of the Navy Department over the signatures of the Chief of Bureau of

Engineering of the Navy Department and the Acting Secretary of the Navy, under dates of March 5, 1924, and March 6, 1924. These dates are prior to the time of my resignation from the Navy. In my official capacity in the Navy Department I arranged for selecting these drawings from the files of Bureau of Engineering and through the regular channels in the Navy Department provided for the certification of the drawings and transmittal to defendant's counsel in this suit.

90. Cross-question. In the concluding paragraph of your answer to direct question 20, you state "I have made a very careful search of the drawing files of the Bureau of Engineering." Who authorized you in the Navy Department to make that search?

Answer. I made the search referred to before my resignation from the Navy. At the time of making the search, I was assigned duty in the Office of the Judge Advocate General of the Navy Department and acted in this particular instance under the direction of that officer.

91. Cross-question. When did you make the search?

Answer. Sometime prior to March 25, 1924, and not more than two months prior to that date.

92. Cross-question. And at the time you made that search, you were chairman of the Interdepartmental Radio Board?

Answer. My last active service in connection with the Interdepartmental Radio Board took place some time in the month of May, 1921. While the Interdepartmental Radio Board has to my knowledge never been officially dissolved, it has in effect been considered inoperative since May, 1921.

93. Cross-question. You answer the question then in the affirmative?

Answer. No; I do not consider that in the performance of the act under consideration that I was in anywise acting as the chairman of the Interdepartmental Radio Board. [fol. 852] Under the circumstances connected with the completion of the Interdepartmental Radio Board's work had new work come to my attention requiring the consideration of the interdepartmental board for the purpose for which it was organized, I would have considered it my duty to have called the attention of the proper authorities to the matter and requested instructions as to whether or not the old board should be considered still in existence for its original purpose.

94. Cross-question. When you testified regarding these Navy contracts defendant's Exhibit L-2, you had resigned from the Navy, but were testifying in regard to matters which you learnt when an officer in the Navy, since you say that the search was made by you prior to the time that you resigned. You have heretofore declined to answer certain cross questions as to matters or acts which you performed touching the interdepartmental board before your resignation from the Navy on the ground that you did not have the expressed consent of the Navy Department so to do. Who gave you express consent in the Navy Department to testify in this case regarding these contracts?

Answer. When I resigned from the Navy, I knew positively that the Navy Department was unwilling to make matters concerning the proceedings of the Interdepartmental Radio Board open to the public. When I resigned from the Navy, I knew positively that the Navy Department was willing for me to testify in this case because I commenced my testimony before my resignation and repeatedly made official trips under official orders from the Navy Department for the purpose of giving such testimony, and the Navy Department was aware of the fact that following my resignation the Department of Justice would continue to employ me for the purpose of completing the testimony. I therefore consider that I had the complete official sanction of the Navy Department to testify in all matters except those which I knew to be withheld by the department, particularly matters relating to the proceedings of the Interdepartmental Radio Board.

95. Cross-question. From what individual or individuals in the Navy Department did you acquire the knowledge that the Navy Department wished certain matters to be withheld by you in your testimony in this case, particularly matters relating to the proceedings of the Interdepartmental Radio Board?

Answer. From the Judge Advocate General of the Navy who at the time was Rear Admiral J. L. Lattimer, United States Navy, under the following circumstances: Numerous requests were received by letter asking the Navy Department to open the files of the Interdepartmental Radio Board for inspection. The first of these requests which came to my desk was taken up by me with the Judge Advocate General, who instructed that in view of the fact that most of the claims which had been considered by the Interdepart-

mental Radio Board had taken the form of suits against the Government in the Court of Claims, and since the Department of Justice is charged with the defense of the Government in these suits that the Navy Department would be governed entirely by instructions from the Department of Justice as to the opening of the files of the Interdepartmental Radio Board for inspection, and to so inform all companies or individuals making such requests, and not to disclose the files until the matter had been passed upon in such manner. In carrying out those instructions I never [fol. 853] had occasion to open the files to anyone through arrangements with the Department of Justice.

96. Cross-question. What other matters than those relating to the proceedings of the Interdepartmental Radio Board did you learn that the Navy Department wished to be withheld from your testimony in this case?

Answer. The Navy Regulations provide for the nondisclosure of all printed matter marked secret, confidential, or for official use only until such time as the publications are officially released from this status, and there is an enormous mass of material in the Navy Department under such status.

97. Cross-question. Are there any other contracts in the drawing files of the Bureau of Engineering during the period covered by the 19 drawings which you have referred to in answer to direct question 20, that is to say, 1904 to 1909, descriptive of sets purchased by the Navy Department during that period of time; or do these contracts comprise all of the contracts for sets purchased by the Navy Department during that time?

Answer. The drawings are merely illustrative of types of sets which were purchased from time to time and I did not examine the contracts to ascertain how many of each type was purchased. Some of the drawings indicate that a number of sets of each type were purchased, specifically naming some of the naval ships chosen to receive the installations. As I recall it, there were duplicates of some of the types showing that types had been bought at different periods destined for different groups of naval ships or naval stations.

98. Cross-question. Was it necessary for you to get permission from anyone in the Navy Department before you could produce and testify about defendant's Exhibit L-2?

Answer. I consider that I had the consent of the Acting Secretary of the Navy, who signed the certificate, the Chief of the Bureau of Engineering, who signed the certificate and the Judge Advocate General of the Navy who transmitted the certificate to the defendant's counsel in this case.

99. Cross-question. And without such consent you would not have felt free to produce defendant's Exhibit L-2 and testify concerning same? Is that right?

Answer. That is not correct. I was at the time a commissioned officer in the Navy with 20 years service charged with numerous responsibilities, and was thoroughly familiar with the Navy Regulations, Navy Department procedure and policy, and particularly familiar with the radio installations of the Navy and those features which it was desired to keep confidential. The particular matter named in the certificate I positively know to be of a nonconfidential character and would not have hesitated to testify as to the particular matter even though it had not gone through the definite official channels status which I have outlined for the particular certificate.

100. Cross-question. Do the Navy Regulations and Navy procedure permit the inspection by one who is not a commissioned officer of the Navy of the drawing files of the Bureau of Engineering from which you selected defendant's exhibit L-2?

Answer. The Navy regulations charge each bureau chief with the responsibility for the preservation of the files, and the matter of inspecting by any one is a matter within the [fol. 854] discretion of the chief of the bureau, except as to secret and confidential matter in which he has no discretion.

101. Cross-question. As I understand you, then, no one could inspect the drawing files of the Bureau of Engineering of the Navy Department from which you selected defendant's Exhibit L-2 under Navy regulations without first obtaining permission so to do from the chief of that bureau?

Answer. From the chief of the bureau, or from some one to whom the chief of bureau has delegated his discretionary powers, and under custom and practice in the Navy Department, such discretionary powers are delegated to a large number of officials.

102. Cross-question. Was it necessary for you, a commissioned officer of the Navy, to obtain such permission?

Answer. No.

103. Cross-question. You have in your direct examination referred to 20 per cent coupling between two circuits, 11 per cent coupling, and 4 per cent coupling. Which of those couplings do you consider loose couplings and which do you consider to be tight couplings?

Answer. Limiting my reply to radio communication practice, 4 per cent would be considered loose, and 20 per cent tight, with 11 per cent somewhat too tight for good selectivity in the Marconi open-gap type of system.

104. Cross-question. Would, in your opinion, 11 per cent coupling be too tight for good selectivity in a transmitter using a quenched gap instead of an open gap or a rotary gap, in radio communication practice?

Answer. The coupling has nothing to do with selectivity in the quenched gap type of system. It would be normally somewhat too loose for good quenching action in the quenched-gap type of system. If used in the Marconi open-gap type of system having a gap or spark producer built along the lines of the modern multiple disc quenched gap it would be too tight for good selectivity.

105. Cross-question. Prior to your resignation as an officer of the Navy, had you considered the file wrapper and contents of the Marconi patent in suit No. 762772?

Answer. Without something to refresh my memory, it is impossible for me to say.

106. Cross-question. As I understand your direct examination, you predicate your evidence upon the proposition that the Marconi patent 763772 is limited in its claims directed to the utilization of a transmitter to a spark gap of the open type as distinguished from the system in which a rotary or quenched gap might be employed?

Answer. That is not correct. I have contended that the Marconi patent, and its transmitter claims, is limited to a system in which oscillations of but one and the desired frequency are created in the primary circuit of a transmitter and are transferred at this one and desired frequency into the secondary circuit, or radiating circuit, without change in frequency. I have not contended that it is necessary to employ the open-gap type of spark producer to create these oscillations of the one and desired frequency, for it may be accomplished with a rotary gap form as well as the modern structure of multiple disc form known as the quenched gap. I have contended, however, that for the "best results" in

the matter of getting a persistent long drawn out train of [fol. 855] oscillations in the primary circuit the open-gap form is the preferred form.

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107. Cross-question. Will you please refer to those portions of the drawings and specifications of the Marconi patent 763772, which in your opinion, requires that the Marconi claims should be limited in the way that you contended for in your last answer?

Answer. Figure 1 of the patent, which refers to a transmitting station, shows a spark producer *c* which as it is illustrated, is of the open gap form, merely consisting of two electrodes, which are spherical in shape. With such a type of gap, if it should be endeavored to quickly throw all of the energy from the primary circuit into a secondary circuit with the object of having the secondary circuit determine the frequency of oscillations, which would necessarily be accomplished by tight coupling, nothing but confusion and disorder would result as the secondary circuit would not be able to hold the energy into itself. The energy would, once in the secondary circuit, be returned through the tight coupling to the primary circuit, as the open type of gap will not quench to stop such return of energy. The result would be a long drawn out repeated transfer of energy from one circuit to the other at two widely separated frequencies. To avoid this action it is necessary to employ loose coupling so that the energy is mainly retained in the primary circuit and slowly fed over into the secondary circuit.

The figure also shows one turn of wire in the primary circuit coupled to but two turns of wire in the secondary circuit with quite a large number of turns in a separate coil *g* in the secondary circuit. Such an arrangement is illustrative of a loose coupling arrangement in the manner I explained in answer to Cross-question 77. The drawing is therefore typically illustrative of a system in which the energy would be retained in the primary circuit oscillating at but one and the desired frequency and slowly transferred to the secondary or radiating circuit.

The Marconi patent states as its object, page 1, lines 15 to 19—"to provide new and simple means whereby oscillation or electric waves from a transmitting station may be localized when desired at any one selected receiving sta-

tion or stations out of a group of several receiving stations."

This object specifically looks forward to creating electric space oscillations of but one and the desired frequency. Without the use of the multiple gap, quench gap developed in about 1909, and therefore not available to Marconi, it was impossible with his system to take the energy quickly out of the primary circuit into the radiating circuit and keep it there. Any effort to do so would have resulted in a repeated transfer of oscillations from one circuit to the other at two different frequencies totally destructive to the object set up in the Marconi patent.

Page 2, lines 12 to 20 of the specification, state:

"My experiments have demonstrated that the best results are obtained at the transmitting station when I use a persistent oscillator—an electrical circuit of such a character [fol. 856] that if electromotive force is suddenly applied to it and the current then cut off electrical oscillations are set up in the circuit which persist or are maintained for a long time—in the primary circuit * * *"

No language could be more definite than that quoted as to where the operative oscillations (the one frequency desired oscillation) are to have their seat of operations, namely, the primary circuit.

Claim 3 contains the following element:

"which include a condenser discharging through a means which automatically causes oscillations of the desired frequency."

The elements referred to in this quotation from the claim are elements in the primary circuit, and the claim requires that these elements "automatically" cause oscillations of the desired frequency. If these elements in the primary circuit transfer this duty to the secondary circuit, they would fail to meet the requirements of the claim of automatic action on their part to create the oscillations of the desired frequency. Numerous other transmitting claims in the patent include the same language.

108. Cross-question. Is it your opinion then that quenched gap transmitters in which there is a close coupling between the primary and secondary circuits should not be included or held tributary to the Marconi patent 763772?

Answer. That is my opinion.

109. Cross-question. What percentage of coupling is embodied in the transmitting apparatus as disclosed in the Marconi patent 763772?

Answer. It is my opinion that to use the Marconi apparatus to accomplish the object set up in the manner set up, as I have quoted in my answer just previous, that the coupling should not exceed 3 or 4 per cent.

110. Cross-question. Please state what the percentage of coupling is in the apparatus which is described in the specification of the patent.

Answer. I consider that the specification, in setting up the objects and manner of operation quoted by me described a coupling not in excess of 3 or 4 per cent. No specific coupling is referred to in the patent.

111. Cross-question. In the Loftin sketch J, have you intended therein to show the progressive amplitude of the oscillations in what you have designated as the lateral circuit?

Answer. The prime purpose of my sketch J was to illustrate the total number of oscillations before the energy fell to 1 per cent of the original in the primary circuit of a Marconi transmitter using the same assumption as to characteristic of the circuit set up by Mr. Waterman, as outlined at page 661 of the typewritten record of my testimony. I calculated the number of oscillations from the mathematical formulas which I set up at page 660 of the typewritten record, arriving at 24 oscillations instead of three oscillations as contended by Mr. Waterman. In making the sketch I used great care to illustrate the total number of oscillations resulting from my calculations and only approximate care in the matter of illustrating the progressive amplitude of the decaying oscillations.

112. Cross-question. Do you agree or disagree with the following statement of what constitutes the essential features of the invention disclosed in the Marconi patent 763772:

"In order to get over a well known difficulty in applying the principle of resonance as between transmitter and receiver in a system of wireless telegraphy, a difficulty involved in the impossibility of a single circuit being at once a good radiator or absorber and a persistent oscillator, the inventor proposed to substitute for a single circuit, in both transmitter and receiver a pair of circuits,

one of which is so constructed as to radiate or absorb or absorb readily and the other of which is so constructed as to oscillate persistently and be a good conserver of energy. The two circuits of the transmitter are tuned together, and linked by means of a transformer in such a way that electrical oscillation in a closed and persistently oscillating circuit build up, and, inasmuch as the primary can act as a reservoir of energy for the secondary, maintains similar oscillations in the open and readily vibrating secondary. Similarly, the two circuits of the receiver, tuned to the same period as the circuits of the transmitter, are linked through a transformer in such a way that electrical oscillations in the readily absorbing primary build up similar oscillations in a closed and conserving secondary until such oscillations have strength to break down the coherer."

Answer. With the understanding that it is the invention disclosed in the Marconi patent, and that I do not admit that Marconi was the one who contributed the invention to the art, and if permitted to insert some explanatory comments which would in no way alter the principle of the invention involved, I would agree that the quotation is a fair interpretation of the system disclosed in the Marconi patent.

113. Cross-question. In what patent granted prior to November 10, 1900, or in what publication published prior to that date do you find disclosed a wireless telegraph receiving system comprising two circuits one of which is an open or absorbing circuit and the other circuit being a closed circuit containing a wave responsive device, the two circuits being tuned or in resonance with one another?

Answer. Limiting the meaning of tuning or resonance to a statement of it in the Marconi patent, and further limiting my answer to the particular date set up in the question, I refer to Lodge patent 609154 of August 16, 1898, that part of the specification referring to the receiving apparatus illustrated in Figure 12 and Figure 13 of the Lodge patent, and particularly the following quotation from page 4, lines 62 to 68:

"In all cases it is permissible and sometimes desirable to shunt the coils of the telegraphic instrument by means of a resistance or a capacity, as shown at w in Figure 12, in order to connect the coherer more effectively and closely

to the capacity areas or receiving arrangement whereby it is to be stimulated."

The providing of a capacity in shunt with the coils of the telegraphic instrument would act to tune the lateral circuit and, as stated by Lodge, "connect the coherer more effectively and closely to the capacity areas or receiving arrangement."

While the Lodge patent is not as full in its instructions as it might have been for the layman, the gap was completely filled by Marconi patent 627650 of June 27, 1899, which is one of the numerous receiving patents referred to in the Marconi patent 762772, as illustrating a receiving arrangement suitable for use in his system. The earlier Marconi patent shows an arrangement in Figure 1 providing for tuning in as specific a manner as is set up in [fol. 858] the later patent. The specification states, in referring to the primary or absorbing circuit of the receiver of Figure 1, at page 1 of the specification, lines 30 to 37 as follows:

"It is desirable that the induction coil should be in tune or syntony with the electrical oscillations transmitted, the most appropriate number of turns and most appropriate thickness of wire varying with the length of wave of the oscillation transmitted."

Page 1, lines 38 to 42 of the specification, provides for tuning the secondary circuits of the receiver as follows:

"The capacity of the condenser on the connection between the imperfect contact and the secondary of the coil should be varied (in order to obtain best effect) if the length of wave is varied."

Here are specifications for tuning both the primary and secondary circuits of a two circuit receiving station using both of the means which had been provided for in the art even prior to the earlier Marconi patent, namely, varying inductance as by varying the number of turns of the coil of wire, and varying capacity as by varying the area of exposure of a pair of conducting plates.

114. Cross-question. An authority who has considered the invention of the Marconi patent in suit 753,772, has made the following statement:

"Is it an essential feature of the Marconi invention that the primary should oscillate so that as energy is radiated

by the aerial the primary will persistently replenish the secondary with at least an equivalent amount of energy, and thereby maintain the radiating secondary? I do not think it is."

Do you agree or disagree?

Answer. I consider that the quotation illy expresses any action that goes on in the system disclosed in the Marconi patent and is totally inadequate in the one feature considered to lead to a discussion of the Marconi system, and therefore is worthless.

115. Cross-question. And you disagree?

Answer. I do not agree that it has any value in a consideration of the Marconi system.

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116. Cross-question. When did you resign from the Navy?

Answer. I submitted my resignation on or about February 26, 1924, and it was accepted and became effective on March 25, 1924.

117. Cross-question. I show you a letter dated October 8, 1920, to the Marconi Wireless Telegraph Co. purporting to be signed E. H. Loftin, lieutenant commander, United States Navy, chairman, and having attached thereto 14 typewritten pages headed "Claim No. 2, Marconi Wireless Telegraph Co." Is that your signature on that letter?

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Answer. The papers handed me relate to matters which at the time of my resignation from the Navy I knew positively were considered confidential by the Navy Department. Since my resignation I have been more or less in close contact with these matters on account of my previous connection with them and I have not been advised of any change in the confidential status of these matters, nor have I encountered any circumstances that would indicate that such status had been changed. For these reasons I refuse to answer the question, until instructed to do by the court, or other proper authority.

Mr. Cosgrove. The commissioner is requested to mark the letter and accompanying typewritten sheets as plaintiff's Exhibit No. 120 for identification.

117A. Cross-question. I hand you a letter dated April 16, 1921, addressed to Messrs. Sheffield & Betts, and pur-

porting to be signed E. H. Loftin, lieutenant commander, United States Navy, chairman, is that your signature?

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Answer. I note that the correspondence refers to the same matters as the correspondence in the question just prior and for the same reason given in my answer to the prior question, I refuse to answer the present question unless instructed to do so by the court or other proper authority.

Mr. Cosgrove. The commissioner is requested to mark the letter just referred to as plaintiff's Exhibit No. 121 for identification.

118. Cross-question. In your answer to question 1, you state "although the board completed its work and made definite recommendations for the settlement of claims, the purpose of the board failed due to the failure of Congress to make the necessary appropriations to cover the recommendations of the board." There was a public hearing before the Committee on Military Affairs in the House of Representatives of the Sixty-seventh Congress on a proposed bill to make appropriations to cover the recommendation of the board, was there not?

Answer. I recall that there was a hearing some time in 1921 before one of the committees of the House of Representatives.

119. Cross-question. In relation to a bill to cover the board's recommendations?

Answer. That was the purpose of the hearing.

[fol. 860] 120. Cross-question. You were present at that hearing and made a statement, did you not?

Answer. Yes.

121. Cross-question. And you furnished to the committee a draft of the preamble of the board's report to the Secretary of War, Attorney General, and Secretary of the Navy, did you not?

Answer. I do not recall definitely whether or not the preamble of the board's report was included in the matter submitted to the committee holding the hearing.

122. Cross-question. I show you a printed pamphlet issued by the Government Printing Office entitled "Hearings before the Committee on Military Affairs in the House of Representatives, Sixty-seventh Congress, First Session,

Monday May 23, 1921." Did you ever see that pamphlet before?

Answer. I do not recall having ever seen the printed report of the hearing, such as you have handed me. I recall having been submitted a proof copy of my statement before the committee for correction.

123. Cross-question. Will you please examine that pamphlet and state whether it refreshes your recollection as to the submission to that committee of the preamble of the report referred to in cross-question 121?

Answer. I believe the preamble was furnished the committee of the House in accordance with a statement I note in the printed copy of my statement to the committee at the time of the hearing.

124. Cross-question. That preamble to the report is contained on pages 29 to 30, inclusive, of the printed pamphlet shown you, is it not?

Answer. I have no way of verifying the matter printed on and between the pages referred to with the copy which I submitted to the committee, but have no reason to believe that it is not a correct reproduction in substance at least.

125. Cross-question. Does this printed pamphlet contain a correct or substantially correct statement or statements, made by you to the committee on that hearing?

Answer. As far as my recollection permits, the printed copy of my statement is substantially correct.

Mr. Cosgrove. The commissioner is requested to mark the printed pamphlet referred to in cross-question 122 to cross-question 125 and answers thereto as plaintiff's Exhibit No. 122 for identification, "Printed Report of Hearing before Military Affairs Committee."

126. Cross-question. You do not deny that you signed the letters dated October 8, 1920 and April 16, 1921, previously referred to in your cross examination, do you? I am referring to plaintiff's Exhibits Nos. 120 and 121 for identification.

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Answer. I refuse to answer for the same reasons and on the same conditions as given in connection with my previous answers referring to the same correspondence.

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[fol. 861] Redirect examination of Mr. E. H. Loftin.

127. Redirect question. In your answer to cross-question 112, you stated that you would agree that the quotation therein referred to is a fair interpretation of the system disclosed in the Marconi patent if you were permitted to insert some explanatory comments. Will you please now make these comments?

Answer. The first few lines of the quotation state as follows:

"In order to get over a well known difficulty, in applying the principle of resonance as between the transmitter and receiver in a system of wireless telegraphy, a difficulty involved in the impossibility of a single circuit being at once a good radiator or absorber and a persistent oscillator."

The difficulty referred to in the quotation in the matter of a single circuit arises from having the spark producer at the transmitter directly in series with the single circuit (the radiating circuit) and the detector at the receiver directly in series with the single circuit (the absorbing circuit). A spark producer in a circuit increases its resistance to a large extent, and is a source of enormous loss as I have explained in my direct testimony. Since an elevated radiating circuit can not be as easily constructed to have large electrical capacity for storing electrical energy as can a closed circuit, since such electrical capacity of the elevated conductor circuit depends upon its physical dimensions, it is apparent that if it also includes a spark producer, the small energy it can take is soon dissipated in its large source of loss. The result is the oscillations do not persist more than a few cycles. I have pointed out that tuning, resonance, or syntony, in the true sense of these synonymous terms depends upon persistency of oscillations. Therefore the single circuit offers serious difficulty in the application of the principle of resonance.

Aside from Hertz, Marconi stood almost alone among the early workers in offering the single circuit system, it having been shown almost exclusively by him in his patents and other works prior to patent 763772, in suit. On the other hand, Tesla, as shown by my sketch A, proposed the two-circuit systems as early as 1894 with the spark producer in the closed circuit, and again, in his patent 645576, of March 20, 1900. The removal of the spark gap from the radiating circuit is also shown by Lodge in his patent 609154 of August 16, 1898, by Braun in his British patent

1862 of 1899, and by Stone in his patent 714756, the application for which was filed February 8, 1900. These publications refer specifically to systems involving the application of electrical principles to electrical communication without wire. During the same period of time there were many showings of spark producers used in connection with wire communication, and such showings almost universally included the spark producer in a primary circuit.

The point is that Marconi seemed to have created a difficulty himself for himself alone.

Similarly at the receiving station, if there is but one circuit including the detector in series, the effect of the detector on the destruction of the resonance capabilities is many fold worse than in the case of a spark producer in the single circuit at the receiving station. A detector is a very high resistance device, being of the order of thousands of ohms, and a circuit that has a high resistance in series with it is termed in the electrical art "aperiodic" no matter what the adjustment of capacity and inductance may be. The term means that the circuit is not capable of resonant response.

In the matter of the receiver, Marconi likewise was practically the only one of the early workers who persisted under this difficulty, but he broke away from it at the receiver earlier than he did at the transmitter, as specifically shown in his patent 627650 of June 27, 1899. In the time prior to patent 763772 in suit, Tesla, Lodge, Braun and Stone at least of the workers in the art showed they were not having any such difficulty as evidence- by the same publications I have just previously referred to. These publications show that these workers provided two circuit receivers with the detector in the closed circuit. The wire art also was not misled, having also used two circuits at the receiving station.

The statement then provides:

"The inventor proposed to substitute for a single circuit in both transmitter and receiver a pair of circuits, one of which is so constructed as to radiate or absorb readily and the other of which is so constructed as to oscillate persistently and be a good conservator of energy."

The only thing shown by Marconi to make one of his circuits radiate readily at the transmitter or absorb readily

at the receiver is the physical arrangement of having the circuit linear or vertical, and the other circuit to oscillate persistently and be a good conserver of energy is the physical arrangement of making the circuit turn upon itself or be almost physically closed. This arrangement was included at the transmitter in the Tesla 1894 organization as shown by my sketch A, the Tesla, Lodge, Braun, and Stone patents just referred to; and at the receiver by the Tesla, Braun, Stone, and 1899 Marconi patents as before.

The statement then provides as to the transmitter:

"The two circuits of the transmitter are tuned together, and linked by means of a transformer in such a way that electrical oscillation in a closed and persistently oscillating circuit build up, and, inasmuch as the primary can act as a reservoir of energy for the secondary, maintain similar oscillations in the open and readily vibrating secondary."

The language here is somewhat lacking in technical precision, but having in mind its effort to interpret the system disclosed in the Marconi patent and give to Marconi's imprecise statements of operation real meaning, I think it intends the following more precise statement:

"The two circuits of a transmitter are adjusted to have the same time period, and are linked by means of a transformer, the linkage being adjusted or of such a nature that the electrical energy is retained in major part or reser-voired in the closed circuit and there manifests itself as persistent oscillations (maintained for a long time), at first building up similar oscillations in the secondary circuit and then, due to the persistency of the oscillations in the closed circuit, maintain similar oscillations in the secondary circuit."

[fol 863] My statement follows Marconi precisely in the matter of adjustment of the two circuits, his statement being that the time periods are adjusted to be the same. It is incorrect to refer to circuits as being in tune, the reference as to tuning being more properly based on the oscillations in the circuit, tuning or resonance being had when the oscillation in the two circuits are the same.

Marconi definitely states that the oscillations in the two circuits should be the same ("similar oscillations"), but provides no instruction for obtaining the specified

result other than the adjustment of a time period, which in itself is not complete as the matter of coupling is of paramount importance. He does provide structures which are typical for the required "loose coupling."

Marconi also provides a type of spark gap or spark producer which is typical of the required persistent oscillations in the closed circuit, namely, the single gap open gap type of spark producer illustrated in Figure 1 of the patent.

So far as satisfying the adjustment definitely specified by Marconi (adjusting the time periods of the two circuits), this is found in the earlier patent to Tesla referred to in the two-circuit transmitter illustrated and described by him. The patent to Stone, 714756, and the Stone to Baker letters, which I have frequently referred to in my direct testimony, go far beyond Marconi in that they not only provide for adjustment of the time periods, but are in themselves full treatises on the subject of "loose coupling," its effect on preserving "similar oscillations" between two coupled circuits, and the manner of obtaining the required loose coupling.

The remainder of the quotation deals with the receiving station, as follows:

"Similarly, the two circuits of the receiver, tuned to the same period as the circuits of the transmitter, are linked through a transformer in such a way that electrical oscillations in the readily absorbing primary build up similar oscillations in a closed and concerning secondary until such oscillations have strength to break down the coherer."

The same explanation is made as to the use of the word "tuned" in this quotation as previously. Marconi definitely provided for adjustment of time periods of the circuits only, and in the specification does not provide any statement as to results desired such as the "similar oscillations" referred to at the transmitting station. There is therefore not the basis in the reference to the receiving station for that part of the quotation which has to do with the two circuits being linked through a transformer in "such a way as to build up similar oscillations" in a closed secondary circuit.

Marconi's 1899 patent made complete provision for the adjustments at the receiver specifically provided for in the later Marconi patent in suit. Lodge's 1898 patent

provided the necessary apparatus with language fully indicating that he had time-period adjustment in mind. The Stone patent and the Stone to Baker letters provided not only for the time-period adjustment, but are full treatises on the subject of the effect of "loose coupling," and the matter of obtaining the required degree with suitable apparatus.

128. Redirect question. In your answer to 106, you state that the open gap is the preferred form for getting best results in the matter of getting a persistent long drawn [fol. 864] out train of oscillations. Will you explain why the quenched gap is not adapted to attain such results?

Answer. The functions of the open type of gap and of the quenched type of gap are diametrically opposed in the matter of persistent oscillations. I have explained in great detail the numerous considerations that enter into the construction of the quenched gap that came into existence in about 1909 to cause it to open up or stop oscillations as early as possible for what the art terms "quenching." It is therefore apparent that a type of gap which is deliberately constructed to remove those qualities which existed in the open type of gap of Marconi's time for the maintenance of a long drawn out or persistent train of oscillations will not give the "best results" that the Marconi specification referred to as resulting from obtaining persistent oscillations. In fact, the quenched-gap type of structure would be totally destructive to such results. My answer points out that a quenched gap will not prevent obtaining oscillations of the one desired frequency in the primary circuit of the Marconi open-gap system; that is, the type of gap has nothing whatever to do with the frequency as this is entirely measured by the capacity and inductance of the circuit, but the type of gap plays an extremely important part in the length of time that the oscillations of the one-desired frequency will endure or be maintained.

129. Redirect question. To one skilled in the art, what do the diagrammatic representations of spark gap and coupling shown in the drawing of the Marconi patent in suit typify?

Answer. The diagrammatic representations as to the gap typify a one gap, open-gap type of spark producer. The diagrammatic representation as to the coupling typify "loose coupling" in two of the manners which I have discussed at length in both my direct testimony and in my testimony in response to cross-questions, namely, the rela-

tion between the turns of wire in the transformer itself coupling the two circuits as well as inserting a large body of inductance in the form of a coil in a part of the circuits, which is not included in the transformer.

130. Redirect question. In your answers to cross-question 114, and cross-question 115, you disagreed with a certain quotation. Will you state your reasons for this disagreement?

Answer. I repeat the quotation:

"It is an essential feature of the Marconi invention that the primary should oscillate so that as energy is radiated by the aerial the primary will persistently replenish the secondary with at least an equivalent amount of energy, and thereby maintain the radiating secondary? I do not think it is."

This quotation infers a relation between the primary and secondary circuits which is measured by the rate at which the secondary circuit can dispose of energy. The Marconi patent does not provide for relating or associating the two circuits on any such basis. The only provision made in the Marconi patent bearing upon the relation (which is the degree of coupling) of the two circuits is that the secondary circuit should be supplied with oscillations similar to those in the primary circuit. This condition is entirely governed by the degree of coupling, and has no other interpretation other than that the coupling must be loose. Having [fol. 865] fixed a loose coupling to give the prescribed similar oscillation in the secondary, the radiating qualities of the secondary circuit may be changed from those of a good radiator to those of a poor radiator or vice versa, as may be done by different physical arrangements of the structure, and yet the coupling can not be changed to meet the variable conditions of rate at which the energy can be disposed without upsetting completely the adjustment for obtaining similar oscillations in the secondary as required by Marconi.

The quotation also gives the idea that the primary circuit always supplies energy to the secondary at the same rate. This of course is entirely incorrect as will be seen by reference to my sketch II, Figures 5 and 5a. When the primary circuit commences to oscillate with a large amount of energy and the secondary circuit has no energy, the transfer is more rapid with the result that the secondary

receives energy faster than it can dispose of it, illustrated as an increasing amplitude in the oscillations in Figure 5a. A little later in the train when the energy in the primary has been reduced to some extent the secondary is not supplied with energy at a rate sufficiently rapid to replenish the secondary with at least an equivalent amount of energy, and the oscillations begin to decay gradually falling to practically zero.

131. Redirect question. Do you find anything in the plaintiff's Exhibit 122, marked for identification, inconsistent with anything that you have testified to in your examination?

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Answer. No. The pamphlet speaks for itself and plainly shows an effort to bring to the attention of Congress numerous considerations leading the heads of several executive departments of the Government to recommend provision for the settlement of a large number of claims based on patents relating to radio in particular, which had been pending and pressed against the Government in numerous ways for a long time. The pamphlet shows that numerous considerations led to the specific recommendation for settlement included in the pamphlet. It points out that to bring all of these claims to final termination through the ordinary channels of litigation would involve years of such litigation accompanied by the usual large expenditures of moneys and use of the time of experts in prosecuting such litigation. It shows clearly that hundreds of patents were considered in the short space of about two and a half years and that these patents were among the holdings of a very large number of claimants. It shows, for instance, that the Marconi Co., one of the claimants, presented about 350 patents, but finally reduced the consideration to 4 patents with the understanding that if a satisfactory settlement could be obtained on the 4 patents the remainder of the 350 would be included in the settlement. It points out that the stated amount of claims of but 7 of the claimants was in the neighborhood of \$15,000,000, leaving 17 claimants who had not set any particular value on their claims, but making it certain that the total claim was many times the \$15,000,000, and that the settlement proposed to Congress, which was acceptable to the claimants was in the neighborhood of \$2,000,000.

[fol. 866] 132. Redirect question. Did Congress pass the proposed bill printed on page 4 of this pamphlet?

Answer. No.

(Redirect examination closed.)

133. Recross-question. In your last answer you do not mean to imply, do you, that the Marconi Co. presented a claim against the Government for the infringement of 350 patents, do you?

Answer. My answer referred in a general way to things brought out by the pamphlet. I find that the pamphlet on page 13 makes the following specific statement as to the subject-matter of your question:

"For instance, the Marconi Co. has about 350 patents. They presented only four patents finally to the board. The board allowed three of these four patents. They will include in their release to the Government all of the 350 patents that they own, and also the one not allowed by the board, so that it will be a complete and sweeping release of that company on practically 350 patents."

134. Recross-question. You haven't answered my question. However, this suit was brought on those four patents prior to the time those patents were presented to the board for consideration under the claim made by the Marconi Co. on those four patents? Is that correct?

Answer. I do not find that the pamphlet lists the patents which are stated to have been finally considered. On page 23, it lists the Marconi Wireless Telegraph Co. as merely retaining for final consideration four patents in number. On page 25, it states that reissue patent 11913 of the Marconi Co. was denied. I recognize the patent listed as denied as being one of those in this suit.

135. Recross-question. You also find on page 26, do you not, the following:

"The board recommend that an offer of settlement be made to the following claimants: The Marconi Wireless Telegraph Co. of America under letters patent of Lodge No. 609154; Fleming, 803684; and the Marconi patent 763772?"

Answer. I do.

136. Recross-question. And you also know, do you not, that this suit was brought on the three patents last referred

to and on the Marconi reissue patent before the Marconi Co. presented their claim finally or otherwise, to the board on those four patents?

Answer. It is my understanding that this suit was filed in 1916. I note on page 23 of the pamphlet a statement that the board commenced to consider numerous claims, including in the list the Marconi Wireless Telegraph Co., sometime prior to September 25, 1919.

Mr. Cosgrove: Plaintiff's counsel offers in evidence the pamphlet referred to as plaintiff's Exhibit No. 122, "Printed Pamphlets of Hearings before Committee on Military Affairs."

The examination by counsel being concluded, the witness, in compliance with the rule of the court requiring him to state whether he knows of any other matter relative to the claim in question, and if he does to state it, says he does not.

E. H. Loftin.

[fol. 867] EDWARD H. LOFTIN, having been recalled as a witness on behalf of the defendant, was examined by counsel for defendant, and in answer to interrogatories, testified as follows:

Direct examination.

By Mr. Edwards:

137. Question. Since the last session of your previous deposition I have made inquiry through the Department of Justice as to whether or not there is objection on the part of the Navy Department to your answering the questions relating to the interdepartmental board which questions were put to you in the course of your cross-examination in your previous deposition, and I am informed that there is no objection to your answering such questions. Will you therefore please refer to cross-questions 45 to 48, inclusive, and state whether or not the Interdepartmental Radio Board made a report with respect to a claim of the present claimant under the Marconi patent 11903, the Lodge patent 607154, the Marconi patent 762773, and the Fleming patent 803684, and whether or not such report was signed by you as its chairman?

Answer. Such report was made and I signed it as chairman.

138. Question. Please answer cross-question 51, which was as follows: Since you say you were aware of the foregoing litigation prior to October 1, 1920, do you not conceive that it was part of your duty representing the Navy Department on the interdepartmental board at this time to thoroughly examine and familiarize yourself with the litigation listed in cross-question 49?

Answer. It was naturally a part of my duty to consider litigation involving the patents before the board and, to the best of my recollection, I did consider all of the litigation listed in cross-question 49. The records involving this litigation were most voluminous and it was, of course, impossible to give them more than their proportionate share of attention that the claim of the Marconi company bore to the whole situation presented to the board.

139. Question. Please answer cross-question 56, which was as follows: "I understand then that you decline to state whether you examined and thoroughly familiarized yourself with personally the records in the litigation listed in cross-question 50?"

Answer. To the best of my recollection, I examined and familiarized myself with the records and litigation listed in cross-question 50. These records were voluminous and received their proportionate share of attention that the claims of the Marconi company bore to the whole situation presented to the board.

140. Question. Referring to your answer to cross-question 117 and cross-question 117a, and to the exhibits marked for identification as "Plaintiff's Exhibits 120 and 121," will you say whether you signed those exhibits as chairman of the radio board?

Answer. I did.

141. Question. Will you now state when and for what purpose the Interdepartmental Radio Board was organized, and who were the members of the board, explain its procedure and set forth the action taken with respect to the Marconi Lodge, and Fleming patents involved in this suit.

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[fol. 868] Answer. I was assigned to duty in connection with such a board in about January or February of 1919,

and, as I recall it, merely by a letter from the Secretary of the Navy to the Attorney General naming me for such duty. It appears that such a board was suggested some time during 1918, and that two officers of the Navy Department were named as members of such a board, but when I arrived in Washington these two officers had been assigned to sea duty and I was undoubtedly the named relief of one of them. As far as any traces were left, nothing appears to have been done by such a board prior to the time I joined it, undoubtedly accounted for by the fact that the war was still in progress when the earlier board was named and had only just finished in the matter of active operations when I reported to duty.

The board which I joined included H. C. Workman, Esq., representing the Department of Justice and chairman of the board; Maj. R. H. Young, United States Army, and Capt. Guy Hill, United States Army, representing the War Department, Commander S. C. Hooper, United States Navy, and myself, representing the Navy Department. Sometimes during the fall of 1919 Mr. Workman severed his connection with the Department of Justice and that department retained Harry E. Knight, Esq., as its representative on the board. I was elected chairman of the board following the resignation of Mr. Workman.

No definite instructions were furnished the board by any one of the several heads of the department who had supplied the members for the board, and the board more or less assumed that no one possessed the necessary knowledge of what such a board might accomplish to furnish such instruction, and it was also appreciated that since the board was an interdepartmental one, there might be some difficulty in obtaining written instructions from any one of the several heads of department represented.

It appeared that several of the larger companies holding radio patents, including the Marconi company, the plaintiff in this case, had asked that a board be organized or some other means provided for recognizing their patents which they contended were being most extensively used by the Government, particularly during the war, and that the Government was placing contracts for apparatus involving their patents with other radio manufacturing institutions.

After a short period of investigation the board which I joined came to the conclusion that if any satisfactory results

were to be had by such a board it would be necessary to include to a fair extent consideration of practically all of the radio patents which might be made the subject of a claim against the Government, and therefore instead of proceeding with merely hearing those companies, which had pressed for consideration, of their patents, contact was established with as many of radio patent holders as could be traced in one way or another, and they were all invited to present claims if they saw fit to do so. The result was that practically all of the important radio patents came before the board in 1919, or shortly thereafter, materializing into about 24 claimants, possessing patents numbering all the way from 1 to about 350 to each claimant. Some of these claimants had previously had some of their patents adjudicated and some of them had made no such effort. Many of the claimants appeared to have no real appreciation of what their patents represented or their relation to the art as it had been or then was practiced. Some of the claimants were more or less familiar with Government types of apparatus and others were not. Under such circumstances, the board found itself presented with a real task, that of trying to allocate in the neighborhood of 2,000 patents with respect to the operations of the Government, and having determined which ones of these patents had been on the face of them used to further determine whether or not they were valid in view of possible prior publications, prior uses, and other general defenses against patents.

The board found the task an extremely difficult one and also one of great responsibility not only on account of the labor of scrutinizing these patents and comparing them with the Government practice, making searches for prior publications throughout the literature of the world, and prior uses that were learned of in many ways, but because it was at once both the defense and the court: that is, it had to create itself the defenses of the Government against the numerous claims under the patents, and then had to pass itself upon these defenses and the arguments brought against them by the claimants. In addition, in the cases of those patents which had been in litigation, and some of them many times, it was necessary to consider volumes upon volumes of records. Many questions arose as to whether apparatus in such litigation was the equivalent of apparatus which had been used by the Government. Many

questions arose as to interpretations which should be given decisions of courts. Much thought was given to the matter of whether or not the board which though lacking definite instructions as to its duties was certain that its purpose was of an advisory nature to several heads of executive departments, should, in making recommendations, take exception with the decision of courts where the board believed there was error in such decisions. For many reasons, including the fact that the board had no authority to swear witnesses, it was decided that the decisions should be accepted as they stood and effort made only in the matter of an interpretation of a decision with respect to Government apparatus.

Serious question was often raised by the claimant and counsel as to the authority under which the board was acting and the prospects of ever having the recommendations of the board, if favorable, materialize into actual compensation to the claimants. There was little or no precedent as far as the board could determine for any such body. It was early appreciated that if the board did recommend substantial compensation to the claimant, there were no funds available out of which such compensation could be paid, due to both the unwillingness of bureau chiefs to expend current appropriations in any such manner and doubt as to the legality of such expenditures under the language of appropriations in case bureau chiefs had been so willing to use their funds. It therefore materialized that [fol. 870] the only hope claimant would have would be in the matter of special legislation by Congress providing a fund, and it was hoped that upon being able to present to Congress a showing of a very careful consideration of the whole situation and a possible saving to the Government of actual expenditures in the matter of final award to the claimants if carried through in litigation and saving of cost of litigation, as well as the practical economical aspects of utilizing the Government's experts and the expert of the companies in development of the art, rather than controversy over what had already been accomplished, as is always necessary in litigation, Congress would be willing to accept substantially the board's recommendations if supported by the several heads of department.

I, as chairman of the board, carefully informed all of the claimants that the proceedings before the board were

entirely on a basis of practical negotiation in an attempt to settle a very complicated and difficult situation, and that the board would use its utmost endeavor to have its effort materialized into effective results to those claimants who succeeded in convincing the board that their claims had merit, but that in view of the absence of any definite authority under which such a board could act and the absence of any provision of law or otherwise to make effective the action of such a board, all hearings and proceedings before the board would be without prejudice in future proceedings, should such be necessary, such as actions in the Court of Claims. The board asked the claimants to freely bring before it and lay on the table all matters of fact considered of value in arriving at the real merit of each case and stated that claimants could do so without fear that disclosures made to the board would not be taken advantage of in case litigation had to be resorted to.

In arriving at its conclusions and recommendations, the board considered that its duty in exercising its double function of both defense and court required bringing forward all of the usual defenses open as against a patent, but in passing upon the defenses raised by itself and the arguments made against them by the claimant the board considered that it had a very broad latitude in weighing matters of doubt to arrive at its recommendation, particularly looking to the saving of the Government long drawn out, annoying, and expensive litigation. The board considered that it had a right to include in its considerations the practical relation of the Government to the development of the art with which the War and Navy Departments had been in close contact ever since its inception and which departments had been the principal incentive for the development of practical radio apparatus in this country. The board knew that the development of radio was not considered anywhere near complete, there being many problems of great value to the military services yet unsolved, and it therefore hoped that it could pave the way for settling by give and take methods well within reason difficulties that threatened to tie up valuable expert talent in passing upon old work. In other words, it felt that if matters in dispute could be settled upon a reasonable basis, satisfying insistence of claimants that they were

entitled to consideration in matters of patents and yet keep the Government in expenditure of funds within what might be hoped for if litigation was carried to a final determination that a valuable service would be accomplished both to the Government and the art in general.

[fol. 871] When the board was first presented with about 2,000 patents to consider, it was unquestionably necessary to reduce this number to something practical if any consideration was to be had at all. Some elimination was readily had through quick conferences with the claimants by pointing out that no use had been made of the particular showing, or that the use was so small, or the patents so unquestionably invalid that they could be ignored if the claimant had other more substantial patents on which to stand. This procedure, of course, led to compromising considerations from almost the very start.

Having reduced the number of patents to something that would be practical to consider, the board proceeded to raise its defenses and very early commenced to state these defenses in the form of preliminary reports or less hurriedly drawn to form a basis of discussion with the board. Such procedure resulted in numerous hearings in which free discussion was permitted, often leading to patents being withdrawn from the board or the board revising its view as expressed in the preliminary reports. This procedure continued on until it was decided that the board must set final hearing on which to base a final report and make effort to secure means for making good the board's recommendations for those claims favorably considered. This final work took place in about May, 1921, nearly two years and a half after the board actively commenced its work.

Taking up the latter part of the question, which concerns the action of the board with respect to the Marconi, Lodge, and Fleming patents, involved in this suit, these patents represent the four patents that the company decided to rest its case upon with the board out of approximately 350 patents owned by the company. All of these patents had been in litigation, the two Marconi patents in suit having been in litigation a number of times. The other Marconi patent 762773 had a number of decisions favorable to it, but none of them involved the quenched gap type of apparatus in the particular form used by the Government. The litigation on this patent prior to the Kilbourne

& Clarke case out West involved the open-type gap, except a motion for preliminary injunction against the Atlantic Communication Co., in which final hearing was started, but the case was never completed, having been stopped during trial on account of Mr. Marconi, who was engaged in testimony or about to testify, being called back by the Italian Government then entering upon the World War. The Kilbourne & Clarke case involved a quenched gap type of apparatus not precisely the same as that in standard use by the Government, because the time period of the primary circuit in which the spark gap was located was not arranged to be adjusted to the same time period as the secondary circuit. Whereas the Government's quenched-gap apparatus had an arrangement for adjusting the two circuits, though the final adjustment is not one in which the two time periods are precisely the same. This left the board with a situation which had not been definitely passed upon by the court, and while it made allowance for [fol. 872] the patent in the matter of the Government's type of quenched-gap apparatus, it was a reduced form of allowance, the situation being unquestionably one where a compromise was necessary.

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In the matter of Fleming patent 803684, it had just been given a very broad interpretation in the suit of Marconi *v.* De Forest. The board did not agree with the decision in this case and there was some dispute as to the interpretation of the decision, particularly as the accounting in the case had not proceeded to a point where the decision was interpreted in the matter of its application to real apparatus. However, in view of the decision and the board's policy of accepting the decisions of the courts then-existing, a recommended allowance was made for the patent.

142. Question. Was there any cross-examination of the claimant or parties appearing on their behalf, or counter-showing by adversely interested parties in the proceedings before the Interdepartmental Radio Board?

Answer. No.

143. Question. Referring to the report of which plaintiff's exhibit for identification No. 120 is a copy, do you find

any statement in the report inconsistent with what you have testified to in your examination in this case?

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Answer. The report covers the four patents in suit and I have testified concerning the two Marconi patents and the Lodge patent and have not testified in the matter of the Fleming patent. As before stated, all of these patents had been in litigation and were the subject each of one or more decisions. The report clearly shows an effort on the part of the board to adhere to its policy of accepting the decisions of the courts where they were definite and left no room for question as to the apparatus involved and [fol. 873] where the decisions were of such nature and based upon such apparatus as to leave open for argument whether or not the Government's apparatus came within the scope of the decisions to compromise with and accept the claimant's interpretation of the decision.

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In discussing the second Marconi patent in suit, I have pointed out that this Lodge patent disclosed impulse excitation such as is employed in the quenched-gap type of apparatus against which the later Marconi patent is being pressed. In this respect I am also consistent with the board's report.

Taking up Marconi patent 763772, the report points out that the prior litigation did not involve apparatus precisely the same as that of the Government's type of quenched-gap apparatus against which claim was being made, and therefore the decision left room for dispute. The report shows that the board in a spirit of compromise accepted the claimant's contention that the exemption by the court in the Kilbourne & Clark case of the Kilbourne & Clark type of apparatus did not free the Government's type of apparatus from the earlier decisions where in non-quenched-gap types two circuits were used and had their time period's adjusted to bring about resonant transfer of energy because the Government's apparatus definitely included arrangements for adjusting the time periods of the two circuits. I have pointed out in my deposition that there is a persistent misuse of the synonymous terms "resonance," "syntony" and "tuning" pointing out the inclination to refer to the mere adjustment of the time

periods of two circuits to be the same as a resonant or tuned condition, irrespective of whether or not the coupling relation between the two circuits is such that they permit of but one frequency existing in the coupled system, and [fol. 874] I have pointed out that resonance depends not upon the time period of the circuits themselves but whether or not the resulting oscillations are of the frequency corresponding to the time period and can resonantly act upon the circuits. This loose understanding as to the meaning of resonance or syntony naturally brought in considerable dispute as to whether or not the Government's tightly coupled quenched-gap transmitters did not come within the meaning of the words "resonance," "syntony" and "tuning," as it had been referred to in the various decisions prior to the Kilbourne & Clark case. After referring to the Kilbourne & Clark case, the board's report states:

"This, however, is not decisive of the present issue, as to the use of quenched gap by the government in which there is a close coupling and a slight or negligible detuning, and in which, undoubtedly, advantage is taken of syntony to secure an effective transfer of energy."

The board, therefore, brings out that the Government apparatus was tightly coupled, and, therefore, did not have a one-frequency condition in which a true resonant transfer of energy from the primary circuit to the secondary circuit could take place, and its reference to "syntony" in the quotation is therefore in the loose form generally meaning that condition in which the time period of the two circuits are independently considered the same. I clearly point out in my deposition that use is made of this adjustment arrangement for transferring the energy from one circuit to the other, but that the use is for quickly bringing about a definite and predetermined beat of no energy in the primary circuit at which the quenched gap can act to open the primary circuit and effectively disconnect it from the radiating antenna circuit. The quotation brings out the slight throwing out of this adjustment to make the beat a perfect one, as illustrated by me in my sketch O, Figure 16. This use of the adjustment of the time periods of the two circuits in the quenched gap system is entirely different from that of the adjustment in the Marconi open-gap system where the purpose is to have a slow, long drawn

out transfer of energy at a definite desired frequency established by the primary circuit, and therefore a truly resonant transfer.

The board's report points out as I have done in my deposition that impulse excitation was provided for in the earlier Lodge patent, and that this impulse excitation is the foundation of the quenched-gap type of transmitter. It points out that the Lodge system did not include the later improvement in the matter of adjusting the time periods of the two circuits to get the definitely located first beat.

The report does not go into the matter of the prior art as I have done, this being unnecessary in view of the policy of the board to not to endeavor to alter the decisions of courts in arriving at its recommendation.

The board touched upon the relation of the patent to several types of apparatus other than quenched-gap spark transmitters, but only one of these types has been pressed in the present suit, namely, the arc type of transmitter. The board contended that this type of apparatus did not come within the terms of the patent which is in keeping with my deposition relating to this patent.

Summarizing, under the board's policy of accepting the decisions of courts where there was no question as to their relation to the Government's type of apparatus in view of [fol. 875] the types that had been in the prior litigation, and discussing the effect of decisions where the type of apparatus passed upon left room for doubt as to the effect on Government's apparatus, the board's scope was naturally extremely limited in the case of a report such as that of the Marconi company where all of the patents had been in litigation. I do not find that any part of my deposition is inconsistent with or in conflict with the report of which plaintiff's exhibit for identification No. 120 is a copy.

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Cross-examination.

By Mr. Cosgrove:

144. Cross-question. Are the 13 or 14 typewritten pages annexed to your letter of October 8, 1920, and forming part of plaintiff's Exhibit No. 120 for identification, a correct copy of the preliminary report of the interdepartmental board on the claim presented by the plaintiff herein to that board?

Answer. I have no way of determining whether or not these pages represent a correct copy of the preliminary report referred to in my letter of transmittal, nor do I believe that there is now any way of determining whether or not these pages are a correct copy, as preliminary reports were drafted from time to time in an attempt to arrive at a final report. I have no reason to believe, however, that these pages do not contain the report referred to in my letter of transmittal of October 8, 1920.

145. Cross-question. Have you any reason to doubt that the pages referred to are the copy of the report referred to in and which accompanied your letter?

Answer. I have not.

Mr. Cosgrove: I offer in evidence the letter referred to as plaintiff's Exhibit No. 120, copy of preliminary report of the Interdepartmental Radio Board on plaintiff's claim accompanying letter of October 8, 1920.

146. Cross-question. Did the board make any final report on the claim of the plaintiff and what form did that report take?

Answer. Yes; a typewritten report was made and submitted to the Attorney General, Secretary of War, and Secretary of the Navy.

147. Cross-question. Presumably that final report is on file in one of the departments of the Government at Washington, is that correct?

Answer. There should be at least one copy in each of the departments of which the officials just previously named are heads.

148. Cross-question. Referring to plaintiff's Exhibit No. 122, printed pamphlet of hearings before Committee on Military Affairs, what relation does the report printed on pages 20 to 31, inclusive, of that exhibit bear to the final report of the interdepartmental board?

Answer. The subject matter contained on the pages named in your question appears to correspond to a part of the board's final report which was termed the preamble.

[fol. 876] 149. Cross-question. According to this preamble to the final report of the board, the plaintiff herein was awarded \$1,253,389.02. Your letter of April 16, 1921, plaintiff's exhibit for identification No. 121, states, "If acceptable, the board's recommendation to the several heads of department will be an award to the Marconi Telegraph Co.

of \$1,253,389.02." What relation does your letter of April 16, 1921, bear to the final report of the board?

Answer. To the best of my recollection, the final report of the board recommended a sum the same or substantially the same as that set up in the letter of April 16, 1921.

(Mr. Cosgrove offers in evidence the letter of April 16, 1921, as plaintiff's Exhibit No. 121, interdepartmental board's letter of April 16, 1921.)

150. Cross-question. Excepting yourself, what qualifications had the other members of the interdepartmental board to deal with or pass upon technical and engineering questions relating to radio apparatus and patents and what qualifications had any of them to deal with or pass upon related legal questions as to the validity, scope, or infringement of the Marconi company's patents upon which they base their claim?

Answer. The technical members of the board were Commander Hooper, Captain Hill, and myself. Commander Hooper to the best of my knowledge has been working in Navy radio matters since about 1908. His work has been more or less of an administrative nature in the matter of directing communication system involving the use of radio apparatus and supplying the naval establishment with its radio equipment. He has never had any particular educational training to qualify him for technical radio work other than the academic course of the Naval Academy. He has little or no knowledge concerning patent law and practice, and never showed any real inclination to delve deeply into such matters. To the best of my knowledge, Captain Hill had an educational training as a foundation for taking up radio work. I understand that he attended courses at the Massachusetts Institute of Technology, probably of a general electrical character, as his attendance was some time prior to 1910, before the educational institutions made any attempt to specialize in electrical communication. I understand that he was employed by some one of the radio companies prior to taking up employment with the Navy Department in radio work about 1913 or 1914. He continued his work in the Navy Department until about 1918 when he accepted a commission in the Army, and has since that time been engaged in radio work for the Army. As far as I could estimate, he had little or no knowledge of patent matters. Mr. Knight and Mr. Young were the members of

the board having patent law experience. It is my understanding that Mr. Knight has been practicing patent law in the neighborhood of 30 years or more, and has had a very wide experience, having handled some very extensive and important litigation, some of it being in connection with radio patents. Mr. Young is a patent lawyer of considerable experience. He accepted a commission in the Army some time in the early stages of the war and thereafter was engaged in advisory capacity in connection with patents for the Bureau of Aircraft Production and I also think in connection with the Signal Corps. As far as I could ascertain, he had no experience in connection with patents involving electrical matters.

151. Cross-question. Do you know whether or not Mr. Knight was counsel for the defendant in the case of Marconi Wireless Telegraph Co. of America against the Atlantic Communication Co. referred to in your deposition?

Answer. It is my understanding that he was.

152. Cross-question. What do you mean in your answer to question 142 by the statement that there was no counter-showing by adversely interested parties?

Answer. I understood the question to mean had the board given opportunity to parties who might have been adversely affected by the board's attitude toward patents which had been presented to it to be heard before the board made its final report, and my answer was intended to state that no such proceedings were had.

153. Cross-question. Would adversely interested parties include parties other than the plaintiff who had presented patents to the board and based a claim against the Government on their patents?

Answer. I do not know, as no such proceedings took place.

154. Cross-question. Did the claims presented by any patentees or owners of patents to the board for adjustment other than the plaintiff herein conflict with or overlap the claims of the plaintiff?

Answer. A claim submitted by the American Telephone & Telegraph Co. did not conflict seriously with the claims of the plaintiff. However, this claim of the telephone company did not last long before the board, as a settlement was made with the War and Navy Departments which permitted the withdrawal of the claim from the board. The conflict as between these two claims would have involved the matter of the interpretation of patents and claims of

patents. After the withdrawal of the telephone company's claims there did not appear to arise any conflict among the claimants as to the overlapping and interpretation of patents. There were matters of adjustment in attempting to arrive at the relative values of contribution of numbers of patents involved in the same piece of apparatus, the patents in many instances being diversely held. The board attempted to adjust these matters for itself and found a little or no inclination on the part of the claimants to interfere.

155. Cross-question. What patent or patents of the American Telephone & Telegraph Co. do you recollect, or what was the nature of the claim of that company which conflicted with the claim of the plaintiff?

Answer. The telephone company owned patent 714756 to John Stone Stone, the application for which was filed February 8, 1900, which I have referred to as prior to Marconi patent 763772. The attorneys and technical representatives of the telephone company in their first hearings before the board set up this patent as prior to the Marconi patent and as being for the same device as the Marconi patent. The telephone company also controlled the De Forest three-electrode vacuum-tube patent, and if they had persisted before the board would have probably brought forward many claims as against the Fleming patent here in suit. Their first hearing before the board indicated that they were fully prepared to do so.

156. Cross-question. You have stated that the procedure of the board resulted in numerous hearings and arguments; [fol. 878] was any stenographic report kept of the hearings before the board at which representatives of the plaintiff were present?

Answer. The board had no facilities for making stenographic notes of the proceedings. An assistant of the board at first attempted to make scattering notes in long hand which I have frequently examined from time to time and found of little or no value. I recall that some of the claimants provided stenographers and notes were kept, but I do not recall that this was done by the plaintiff.

157. Cross-question. Did the board in considering technical matters relating to radio apparatus and patents have the benefit of the advice of any experts and engineers other than the individual members of the board?

Answer. To a limited extent technical advice was sought from several sources.

158. Cross-question. Were those sources qualified to give such advice?

Answer. Some of the instances resulted in advice considered of no value and in some instances the advice was considered of assistance.

159. Cross-question. Did not the hearings before the board so far as they related to the claims of the plaintiff and at which hearings the plaintiff was represented consist of discussions by the board or members thereof on the one hand and the plaintiff's representative or representatives on the other hand?

Answer. Yes.

160. Cross-question. In none of the hearings before the board on plaintiff's claim were witnesses produced and examined and cross-examined by the plaintiffs or the Government, is that correct?

Answer. No sworn testimony of any kind as introduced into the board's proceedings.

161. Cross-question. The first hearing before the board on the plaintiff's claim at which hearing a representative of the plaintiff was present, was about the middle of October, 1919. Is that not so?

Answer. I can not recall.

162. Cross-question. Have you any way of fixing that date?

Answer. No.

163. Cross-question. Referring to plaintiff's Exhibit No. 122, I find the following on page 23 of the preamble to the board's final report:

"The board thereupon proceeded to consider the several hundred patents set forth in these claims, and on September 25, 1919, had progressed so far with this examination that a letter was sent to the several claimants appointing hearing."

Does that help to refresh your recollection as to the date the first hearing was had on plaintiff's claim at which hearing a representative of the plaintiff was present?

Answer. I have no reason to believe that the quotation does not state the fact, and I believe that a hearing was had with the Marconi company shortly after the date set up in the quotation.

164. Cross-question. Was that the first hearing on the Marconi claim at which a representative of the Marconi company was heard?

Answer. I believe that the board met with representatives of the Marconi company before that date, though I have nothing in mind at present to make the matter definite.

[fol. 879] 165. Cross-question. That is, you can not fix the date of the hearing referred to or who was present at that hearing on behalf of the plaintiff?

Answer. No.

166. Cross-question. Between September, 1919, and October 8, 1920, the date of your letter forming part of plaintiff's Exhibit No. 120, no hearings were had before the board in respect to the plaintiff's claim at which a representative of the plaintiff was present; that is correct, is it not?

Answer. I don't think so. As I recall it, there were hearings from time to time amounting possibly to five in number, and I believe one or more of them came within the dates specified in the question.

167. Cross-question. When and where were these hearings and who was present at them?

Answer. The hearings took place in the Navy Department at Washington, always with a quorum of the board present. As I recall it, the Marconi company was always represented by Mr. Betts, as counsel, and he varied to some extent the personnel accompanying him. I recall no definite dates of hearings.

168. Cross-question. As a matter of fact, the hearings you refer to were after your letter of October 8, 1920, with the accompanying preliminary report, was sent to the Marconi company, isn't that true?

Answer. I do not know that it is true.

169. Cross-question. Well, is there any record anywhere which will show the date of these hearings and who was present at them?

Answer. There are some scattered notes made by an assistant of the board in the manner I have just heretofore explained, but I am afraid that they are of such a nature that it will never be possible to establish through them a series of dates of hearings that can be relied upon.

170. Cross-question. At the hearing before the Military Affairs Committee reported in plaintiff's Exhibit No. 122, you stated, did you not, "The board finally came down to a real serious consideration of 149 patents. This considera-

tion involved searches of the art, writing of long reports, receipt of briefs from claimants, hearings, more briefs, revised reports, . . .”

Answer. I believe the quotation is correct.

171. Cross-question. At this hearing you were asked certain questions and in answer thereto made the following replies, did you not?

“Mr. Morin: The allowance has been based on the use of the patents that have been found valid?

“Commander Loftin: Yes; and the manufacture also. This whole settlement includes the contractors for the Government as well as the Government, the particular necessity for that being that the Government has agreed in many cases to save the contractor harmless. Now, under the act of 1918 we have the entire responsibility anyway.

“Mr. Morin: You have not allowed any claims where the validity of the patent is in doubt?

“Commander Loftin: No, sir; unless the doubt was such that it could reasonably be resolved in favor of the patentee. I might say here that I am informed that the courts generally lean over backward to sustain a patent, but I do not think we have gone quite that far. We have required them to come somewhere near the middle ground before we have held that the patent is good. But the courts are very liberal with inventors and will generally resolve a very strong doubt in their favor.”

Answer. I believe the quotation is correct.

172. Cross-question. Do you not find the following statement in the preamble to the board's final report as incorporated in plaintiff's Exhibit No. 122:

“In the case of each claimant the various patents have been carefully examined with the aid derived from briefs or oral arguments submitted, and the board has, where necessary, examined the history of the patent as disclosed by the Patent Office record and reports of litigation, and has made as extensive a search of the prior art as has seemed necessary in each case.”

Answer. I do.

173. Cross-question. You have stated that the board's preliminary report does not refer to the prior art and in another place you state that there was no necessity for the board touching the prior art as you have done in this case.

Were not the board's preliminary and final report so far as they may relate to the plaintiff's claim based upon a consideration of the prior art?

Answer. In the case of the Fleming patent it was not. There were court decisions on this patent which, in view of the nature of the apparatus involved in the earlier litigation and the board's policy of not attempting to re-adjudicate patents, made it unnecessary to introduce prior art into the board's report. In the case of the Marconi patent 762773, the board's report does refer to the earlier Lodge patent as being the fundamental patent covering the quenched-gap type of apparatus, because the prior litigation had not covered apparatus the same as the Government's quenched-gap transmitter. In other words, the board did not include prior art where the decisions made it unnecessary and did include prior art where the decisions permitted. In the first part of my answer I neglected to point out in connection with the Fleming patent the board did refer to the earlier Edison patent on the same device used in connection with the low-frequency work, and pointed out that in view of this earlier patent no allowance would be made for vacuum tubes employed in low-frequency systems or in systems involving a combination of high and low frequencies on those portions of the systems which took up the low-frequency function.

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174. Cross question. In the report of the Military Affairs Committee forming part of plaintiff's Exhibit No. 122, Mr. Knight is reported as stating that the attitude of mind of the board in considering claims was to "try to find out as far as we could what the Court of Claims, which would be the tribunal hearing these cases against the Government, would do in the way of awarding fair and just compensation under the present act of Congress." Later Mr. Knight is reported as stating that the board—

[fol. 881] "examined to see whether he had a valid patent, and then we have examined to see how broad that patent was, what its scope was, and we have tried to find out how many and what apparatus the Government had made which were under patent. That gave us some basis of estimating what payment should be made. If we thought the patent invalid or insignificant, that the improvement was not

worth paying for, we have so declared; but if it was a substantial improvement and the Government used it and had the advantage of the invention and it was a legal claim which the Court of Claims would allow, we have in that case favored the claim.

Assuming that Mr. Knight is correctly reported, do you agree with his statements?

Answer. Assuming that these quotations are correct, I do not agree that they, taken by themselves as they are from a long series of statements, repeatedly interrupted by questions from the committee, precisely state the attitude or mind of the board; that is, my understanding of its attitude or mind, and I think perusal of the entire statement of Mr. Knight of which these are but fragmentary quotations brings out the reason why I can not entirely agree.

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178. Cross-question. Well, the plaintiff only relied upon its patents which had been adjudicated in presenting its claim to the board; is that not correct?

Answer. The negotiations finally came down to that.

179. Cross-question. Did the board in reaching its final conclusions on the plaintiff's claim follow or adhere to the decision of Judge Veeder in the case of Marconi Wireless Telegraph Co. *v.* the Atlantic Communication Co. granting a preliminary injunction restraining that company from using a quenched-gap transmitter in infringement of certain claims of the Marconi patent 763772?

[fol. 882] Answer. The preliminary injunction proceedings referred to received the attention of the board, but, in accordance with my understanding of the attitude of the board, no particular weight was given to these proceedings on account of being merely of a preliminary injunction order.

180. Cross question. Did the board take this attitude in respect to every decision on a motion for preliminary injunction involving any of the patents of the plaintiff which were presented to the board for consideration and which are involved in this suit?

Answer. I do not recall any other motion for preliminary injunction other than the one just cited being pressed before the board by the plaintiff, in support of its claim. That is, I do not recall that any other motions for prelimi-

nary injunction were considered by the board in passing upon the claims of the plaintiff.

(Cross-examination closed.)

(The examination by counsel being concluded, the witness, in compliance with the rule of the court requiring him to state whether he knows of any other matter relative to the claim in question, and if he does to state it, says he does not.)

(Deposition closed.)

GREENLEAF W. PICKARD

At the request of counsel for the Government and subject to correction should error appear, it is stipulated that if Greenleaf Whittier Pickard were called as a witness on behalf of the Government he would testify as to the following portions of his testimony given in the case of Marconi Wireless Telegraph Company of America v. Kilbourne & Clark Manufacturing Company in the United States District Court for the Western District of Washington, Northern Division, on the 23d day of March, 1916, through and including the 29th day of March, 1916, and that copies of the following portions of said testimony and the exhibits offered in connection therewith may be received as a correct statement of said testimony, with the same force and effect as if said witness had been duly called, sworn, and examined on behalf of the Government in this cause.

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Question. Will you please state briefly the history of radiotelegraphy and the condition of that art with relation to the Lodge and Marconi patents here in suit, with particular reference to the circuits and apparatus therein involved and their relation to each other. You may preface this answer by a brief explanation of the mode of operation of radio telegraphy?

Answer. The next contributor to the prior art is Prof. John Stone Stone in defendant's Binder A-8, which is Stone patent 714756.

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[fol. 883] In Figures 5 and 6 of this Stone patent, No. 714756, are shown a transmitter and a receiver, consisting of at the transmitter a closed oscillatory circuit C-S-i-1-L

inductively associated with an open or radiating circuit, V-M-i-2-E. That is Figure 5. At the receiver, Figure 6, an open absorbing circuit V-i2-E is inductively associated with a closed circuit, i1, C1, CL, this latter circuit being connected to a detector K which in turn is connected to an indicator R and a battery B. Returning to the transmitter, the original source of power is shown as the alternator A--- (I may remark parenthetically that the symbol shown at A is the conventional symbol for an alternator, that is two interlinked circles with two slanting lines above and below. This is supposed to represent the two rings of an alternator with the two brushes bearing thereon). This alternator supplies through a telegraphic key K a step-up transformer, ii-i2. The secondary terminals of its winding i2 are connected to the condenser C, and when the key K is pressed currents from the alternator A will flow through the primary winding i1 of the stepup transformer M, will introduce in the secondary winding a high potential which will charge the condenser C, and this in turn will discharge across the spark gap S, and through the inductance i1 and L thereby setting up persistent oscillations. I say persistent oscillations because the specification of this patent at a number of places lays great stress upon the careful construction of the condenser C and the coils i1 and L, in order that there shall be the minimum resistance or loss in these elements, so that the most persistent oscillations may be obtained. These oscillations are transferred from the circuit C-S-i1-L to the opening or radiating circuit through the oscillation transformer (or as it is now termed inductive coupler), i1-i2, to the open or radiating circuit V-Mi2-E. Similarly at the receiver of Figure 6 the received current alternations or oscillations pass through the open or absorbing circuit, V-i2-E and by reason of the association of this open circuit with the closed circuit, C-i1-L-C, through the oscillation transmitter or inductive coupler M, set up oscillations in this closed circuit. The specification states, page 2, line 16 to 18, "The frequency impressed upon the elevated conductor may or may not be the same as the natural period or fundamental of such conductor." That is to say, the circuit shown in Figure 5 may be adjusted to be in resonance, or if preferred for some of the special purpose which are elsewhere set forth in the specification, may be purposely put out of resonance, that is out of tune. Similarly at the receiver, Figure 6, the circuit V-i2-E may

or may not be placed in resonance with the closed receiving circuit C1-L1-L-C1. The reason why in this patent the constructor is given the choice, so to speak, of whether or not he tunes the two circuits is shown by some of the other [fol. 884] forms of apparatus disclosed in this patent, such for example as the transmitter and receiver combinations of Figures 13 and 14. Without going into any lengthy description of this, I will say that this arrangement is for multiplex radio communication, in which two sets of closed primary circuits at the transmitter, Figure 13, were associated with a single elevated conductor. Of course the elevated conductor could not be in tune with both at the same time, two circuits of different frequencies. Therefore, as Stone states, in the specification, this elevated conductor of Figure 13 V-M-M1-E was to be either an aperiodic circuit, that is one without any tune at all, or a circuit which might be out of tune, though still having a tune of its own. Stone's object was simply to force or impress vibrations of different periods upon this radiator from the closed primary circuits. Similarly at the receiver in Figure 14 a single absorbing circuit V-M-M1-E is shown and associated with this are two separate tuned receiving circuits, these being the circuits C1-L-C1 Sub 1; L1-Sub 1, which specification states are tuned to different periods.

In February, 1899, Professor Stone disclosed to me a system of transmitting receiving circuits such as are shown diagrammatically in Figures 5 and 6 of the Stone patent I have just discussed. This disclosure was some time in the latter part of February, 1900, and took place at the office of a Mr. Maynadier, which, as I remember it now, was at the corner of Court and Washington Streets, in Boston, Mass. I at that time was acting as technical adviser for an early American radio telegraphic company, and this company, which controlled or owned the Dolbear patents on radio telegraph, had been approached by either Mr. Stone or some of his representatives to see if they would be interested in the commercial application of his inventions. Shortly before this conference with Professor Stone I was informed by Mr. Learned of the Dolbear Co. (may remark parenthetically I have forgotten this company's exact title so I have called it herein the Dolbear Co.), Mr. Learned telling me that Professor Stone had some interesting inventions in the line of some selective or sharply

tuned radio telegraphic apparatus, and that he wished me to meet Stone, and his, Learned's, attorney, Mr. Maynadier, to discuss this matter and to see whether or not these inventions would be of use. Pursuant to this conversation with Mr. Learned I went over to Mr. Maynadier's office and met Professor Stone, and as I now recall we had a conversation lasting some hour or two, perhaps the greater part of the forenoon, in which Stone disclosed to me his system of radio telegraphy. At the transmitter Stone proposed to use for the primary circuit a closed oscillating circuit, using air condensers and carefully constructed inductances so as to avoid any possible loss and to obtain the greatest persistency and purity of wave. And that, associated with this closed persistent oscillating circuit at the transmitter, was to be linked or connected to an open or radiating circuit, which was to be tuned or brought in resonance to the period of the primary or closed circuit. At the receiver he proposed to use an elevated conductor and a ground connection, forming an open circuit, and to tune this circuit to the two circuits at the transmitter, and lastly to associate with this third circuit at the receiver a fourth or closed circuit which should either include or be connected to the detector, and that this fourth circuit should be tuned to all of the three preceding circuits; that is to say to the closed [fol. 885] oscillating circuit at the transmitter, the open radiating circuit at the transmitter, and the open or absorbing circuit at the receiver. At this same conference with Professor Stone he also disclosed to me some further inventions, which as I remember consisted of having a plurality of circuits at both receiver and transmitter. That is to say, instead of directly connecting or associating by means of the oscillation transformer, his closed persistent oscillary circuit with his open or radiating circuit, he suggested the use of an intermediate, or I believe he called it a "weeding-out" circuit, interposed between the first or closed oscillating circuit and the open radiating circuit. Similarly at the receiver he proposed to use an intermediate circuit between the open absorbing circuit of the receiving station and the closed detector or secondary circuit. When these intermediate or weeding-out circuits were used, Professor Stone explained to me they also were to be tuned accurately to the frequency of all the other circuits. In addition to this disclosure Professor Stone also explained

to me a simple means by which he attained what is called loose coupling; that is, a less intimate association of, say, the two circuits at the transmitter. This, I recall, he did by means not of removing one coil, such as, for example, the coil L of figure 2 of my sketch G W P 10, from the coil L1 of the other circuit, but by inserting in one or the other of the two circuits a large inductance coil. I think I can recall his exact language, which was that this coil would have the effect of swamping the coupling or coil inductance of the transformer and so loosen the coupling, the object of this loose coupling being to allow the circuits to vibrate more freely than if they were too intimately associated with each other. At the time, or a few days after this conference, I made a note in my diary as to this conference and to the fact that Professor Stone had disclosed a selective system of radiotelegraphy to me, embodying several resonant circuits, and although I have not this diary here with me to-day, nor have I a copy of it, I can produce this copy later. The original diary, I understand, is now an exhibit in an eastern court.

The Court: This concludes the record in relation to Stone?

Answer. To Stone; yes.

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My recollection of Professor Stone's disclosure to me of his system of radiotelegraphy has, within the last year or two, been refreshed by reference to a note in my diary, and, within the last day or so, has again been refreshed by reference to a photographic copy of the pages of my diary containing these notes. I have here a photographic copy of that portion of my diary containing the notes as to Professor Stone's disclosure. The original diary, I understand, is now an exhibit in the court in Brooklyn, and is not available to me.

[fol. 887] Question. Has that been identified, Mr. Pickard? Has that been identified? Did you refer to it before?

Answer. No; I did not refer to it before.

Mr. Skeel: Then I offer it in evidence.

The Court: Let it be marked as the next exhibit of the defendant, whatever it may be.

(Admitted and marked "Defendant's Exhibit 7".)

The Witness: Under the date of February 28, 1900, I find the following short note: "Am now examining some patents offered to Learned. Most of these entirely impracticable. J. B. Stone has interesting system of several resonant circuits and claims great selectiveness." I find, immediately preceding this note, under the date of February 24, a note reading as follows: "60 Sta. today, my first out-of-door trip." These two notes from my diary recall to me the exact circumstances, which are briefly as follows: In the winter of 1899-1900 I was confined to the house with a severe illness, and I did not get out of doors until some time in February. Immediately upon my first visit to the office of Mr. Learned, which, as I now recall, was the first day I got out, Mr. Learned asked me to investigate and confer with Professor Stone as to his system, and, as appears from my diary notes, which were made at intervals of approximately one week, this conference of mine with Professor Stone apparently was some time between February 24 and February 28. I recall, although only vaguely, several other conferences with Professor Stone subsequent to this—within a period of a week subsequent, in which he, as I recall now, merely amplified and gave further details of his first disclosure.

I have prepared a chart showing in the two figures—the left and the right hand figures—the Stone transmitter and the receiver. This chart is entitled "Pickard Chart of Stone Four-Circuit Tuning Patent." (See vol. 2, p. 544.) The left-hand figure, as I have said, is the transmitter disclosed to me by Professor Stone, consisting of the following elements: A closed, oscillating circuit, D E C L, the element D being an inductance coil, constituting the primary of an oscillation transformer; the element L being another inductance coil, which as I have stated, was explained to me by Professor Stone as a means for loosening the coupling between the closed and the open circuit, and thereby obtaining a purer wave; that is to say, a wave more adapted for selectivity or sharpness of tuning between the receiving and transmitting stations. The element C was a spark gap, and I do not recall that Professor Stone disclosed to me any particular form of spark gap. He simply stated that it was a spark gap. The element E was a variable condenser, preferably having air as a dielectric. Professor Stone insisted upon that, as I recall, because, as he said, such a condenser had practically no loss due to

hysteresis, as it is called, which is found in other condensers, such as those constructed of glass, like the ordinary Leyden jar. The source of potential for charging the condenser E, shown in my chart at A B, was disclosed to me by Professor Stone as either an induction coil, or an alternating current transformer. The open or radiating circuit, A 2 D' 2, was disclosed to me by Professor Stone as an elevated conductor A, which might be a wire or group of wires [fol. 888] running up into space to any desired height, a ground connection E and interposed between the aerial A and the ground connection E, was the secondary of the oscillation transformer, consisting of the winding D'. Professor Stone stated at our first conference that the closed oscillating circuit D E C L of my chart, was to be tuned or made resonant to the open oscillating circuit A' 2 B' 2 E.

At the receiver shown in my chart of the Stone system, at the right-hand side, the open receiving or absorbing circuit A 3 J' 3 E, was to be placed in tune or resonance with the two circuits at the transmitter. This open or absorbing circuit at the receiver comprised the following elements: An elevated conductor A, a ground connection E, and the primary winding of an oscillation transformer J'. Inductively associated with this first or absorbing circuit of the receiver was a closed oscillating circuit shown in my chart of the Stone system as an inductance winding, constituting the secondary winding of the oscillation transformer J²; a variable condenser H'; a second fixed condenser J³; a second inductance G². Professor Stone explained to me these elements substantially as follows: That the condenser H' of the second or secondary circuit of the receiver was to be as shown in the transmitter in the left-hand figure—a variable air condenser; that the inductances J² and G² were to be air core inductances, constructed to have the minimum resistance or resistance losses when traversed by high frequency alternating currents. Connected to this closed, oscillating secondary circuit at the receiver in the manner commonly known as a shunt or parallel connection, was placed a detector, such as a coherer, T, and its local or indicating circuit, including a battery, B, and a receiver, R. Professor Stone stated to me that this secondary circuit J²H'H²G² was to be tuned or made resonant to the open absorbing circuit, A', 3, J¹, 3, to the open or radiating circuit of the transmitter at the left-hand figure A 2 B' 2 1 E and also to the closed persistently oscillating cir-

cuit E C L D of the transmitter. I have not shown in this chart the further modification which I have already testified Professor Stone disclosed to me, wherein, at the transmitter shown at the left-hand figure and between the coils D^1 and D was placed a so-called weeding out or tertiary circuit—a third circuit of the transmitter. Neither have I shown at the receiver a modification, which I have already testified was disclosed to me by Professor Stone, of an intermediate or tertiary circuit interposed between the windings J^1 and J^2 of the receiver at the left-hand figure of my chart. However, when these were used, the system then became a three-circuit system at both transmitter and receiver; that is to say, there were in the complete system, embracing both transmitter and receiver, six tuned circuits, all tuned to the same frequency.

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Question. Was this third circuit disclosed to you at the same time as the others?

Answer. Yes. The third circuit was disclosed to me at the same time, at the same conference with Professor Stone. I may say, before concluding, that this disclosure to me was partly verbal and partly by sketches. Professor Stone did not at that time show me any actual apparatus in operation. He simply told me, as I recall very clearly indeed, just what the elements were, and made that even clearer by [fol. 889] sketches, the sketches being, as I recall them, substantially the sketches I have made here upon my chart. It was not, I think, until two or three years later that I actually saw a Stone transmitter and a Stone receiver in operation, constructed according to Professor Stone's disclosure to me, and also according to the diagrams which I have given in my chart, "Pickard Chart of the Stone system," as illustrative of his disclosure.

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Question. Will you please give this chart the number G. W. P. 10a?

Answer. Yes. I had better place that on it myself. That was very careless of me. I should have thought of that.

(The chart referred to was thereupon marked by the witness "G. W. P. 10a").

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The Witness: The Stone 1899 system, which I have illustrated, is taken from Stone's disclosure to me in 1899, and at the left-hand figure, the transmitter, I have shown the closed, persistently oscillating primary circuit, inductively coupled with the open radiating circuit, and in the right-hand figure, I have shown Stone's open absorbing circuit inductively coupled with a closed persistently oscillating secondary or detector circuit. As I have stated, these four circuits were specified by Professor Stone as being tuned one to the other—that is, all four circuits were tuned to the same frequency.

Cross-examination:

Question. I now refer you to your chart G. W. P. 10a marked "Pickard Chart." Did you originate the words on this chart reading as follows: "Stone four circuit tuning patent 714756 filed prior to Marconi's filing and granted prior to Marconi's new defense as to validity and noninfringement in pending Brooklyn trial against Atlantic Co.?"

Answer. I originated those statements. I am not entirely responsible for the exact phraseology, as that was arrived at in conference between myself and one of the attorneys in the case. The statements are my own, however.

Question. And you originated also the statement of this chart "New defense, almost identical with figures 1 and 2 of Marconi patent in suit. Never before used in trial against Marconi patent save in uncompleted trial in Atlantic Communication case."

Answer. Those are my statements of facts known to me.

Question. I ask you whether you originated those statements on that chart?

Answer. I did.

Question. From what prior patent or publication of Stone's in 1899 did you take the transmitter shown in G W P 11?

Answer. This transmitter is shown in figure 5 of Stone's United States patent No. 714756.

Question. Granted when?

Answer. Filed February the 8th, 1900, and granted December the 2d, 1902.

[fol. 890] Question. In what patent of Stone's do you find a receiver such as you have illustrated in G W P 11 opposite "Stone 1899"?

Answer. The same Stone patent No. 714756 in Figure 6.

Question. That patent wasn't granted until 1902, is that correct?

Answer. That is correct, as appears from the patent before me.

Question. At the time that Mr. Stone made this disclosure to you such as you have referred to in your direct examination did he show you a copy of the application for his patent which had been previously filed?

Answer. No; he did not.

Question. You testified, did you not, Mr. Pickard, to this same matter in a suit of Marconi against the Atlantic Communication Company?

Answer. Yes; I did.

Question. And didn't you testify May 11, 1915 as follows:

"Cross-question 52. Now, just state fully, exactly what Mr. Stone said to you when he made this alleged disclosure?

"A. As I now recall Mr. Stone's disclosure to me he said that he had devised a system for radio communication, which would give far higher selectivity than any of the systems at present in use. He described the means by which he obtained this increase in selectivity, broadly as being a very loose coupling between his circuits. He then showed me one way in which this loose coupling could be obtained, which was by inserting additional inductance in one or both of the coupled circuits, I mean by that, inductance additional to the inductance of the windings of the oscillation transformer. He then went into a rather long description of the system employing a multiplicity of tuned and loosely coupled circuits at both transmitter and receiver, stating, as I recall, that this would have the advantage of still further selectivity owing to the weeding out effect of several tuned circuits interposed between the receiver and the aerial and the detector circuit, and that a similar effect would be produced at the transmitter by an interposition of several tuned circuits between a primary or condenser discharge circuit and the transmitting or radio circuit aerial.

"Cross-question 53. Is that, as near as you now can put it, what Mr. Stone's disclosure to you was in the last week of February, 1900?

"A. That is all that I now recall."

Did you so testify?

Answer. Yes; I recall the substance of that language.

Question. Now, in your note book that you referred to on direct examination here, there are no diagrams of any circuit arrangements of Mr. Stone's disclosure to you?

Answer. No.

Sheffield & Betts, Attorneys for Claimant. Clifton V. Edwards, Special Assistant to the Attorney General. Herman J. Galloway, Assistant Attorney General.

Dated New York, N. Y., March 13, 1925.

[fol. 891] *Deposition of Joseph O. Mauborgne, for Defendants, Taken at New York City, on the 16th day of March, A. D. 1925*

JOSEPH O. MAUBORGNE, having been produced as a witness on behalf of the defendant, was by me sworn, before any question was put to him, to tell the truth, the whole truth, and nothing but the truth relative to the said question, and thereupon deposed and said that his name was Joseph O. Mauborgne; that his occupation is major, Signal Corps, United States Army; that he is 44 years of age; that his residence is Washington, D. C.; that he has no interest direct or indirect in the claim in controversy; and that he is not related to the plaintiff; and thereupon the said Joseph O. Mauborgne was examined by counsel for the defendant and in answer to interrogatories testified as follows:

Direct examination.

By Mr. Edwards:

1. Question. Please state what experience you have had in the use of radio apparatus and in keeping in touch with the development of the radio art?

Answer. My first interest in radio was due to the yacht races some time around 1898 or 1899 in which Mr. Marconi employed wireless communication for the New York Herald in reporting the results of these races. I was at that time pursuing a collegiate course in the College of

St. Francis Xavier, this city, resulting in my graduation with an A. B. degree in 1901. While not a scientific school, the course in science was a very good one and was accompanied by a considerable amount of laboratory work. During the course of this I had a chance to have access to apparatus including a coherer, spark coil, etc., with which the very elementary principles of the transmission of Herzian waves were demonstrated. I purchased at that time several books on radio including Fahie's History of Wireless Telegraphy, and from that time on have followed the development of the art through reading and experimental work.

In 1903 I was commissioned as a second lieutenant of Infantry in the United States Army and served at Fort Leavenworth, Kans., until the early part of March, 1905, when I was transferred to the Philippine Islands.

In the year 1906 my regiment was moved to Zamboanga, Mindanao, where I observed the erection of the first radio station in the Philippines, established by the Signal Corps. As signal officer of the post at Zamboanga I had occasion to examine the various devices used in that installation. Later I visited the island of Jolo, where the companion station to the Zamboanga station was being erected, and I observed that the same type of construction and connections of apparatus was then installed, though the station was not finished and in operation until after my departure for the United States in November, 1906. During the period from my return to the States until the year 1909 I experimented with radio in my own home so that by the time I was ordered to the Army Signal School, Fort Leavenworth, Kans., in August, 1909, I had accumulated a considerable quantity of radio apparatus and entered the school with a complete transmitter and receiver installed in my quarters.

[fol. 892] From 1909 to 1910 I was a student at this school and took a course in signal engineering, which included, among other things, a study of direct and alternating current and radiotelegraphy. The Army Signal School at that time had a very well-equipped laboratory containing not only the then existing types of radio apparatus in common use, but also some of the very earliest pieces of apparatus ever used by the Signal Corps of the Army in connection with radio work; among other things I remember some untuned spark coil transmitters and receivers, coherers of the very earliest type, two sets of Marconi receiving appa-

ratus employing a tapper on the coherer, a Lodge-Muirhead receiver with a form of detector consisting of a steel wheel touching a cup of mercury, a Marconi magnetic detector, crystal detectors of various types, various transmitters and receivers used by the Signal Corps from the earliest kinds covering the spark stage development.

During the summer of 1910 I was on duty with a field company of the Signal Corps during the maneuvers in which the first Telefunken wagon set using a quenched gap was employed. Prior to my graduation from the Signal School in 1910 there was used and tested at that school two quenched spark Telefunken sets with bicycle-driven ventilators. It is thus seen that during that period from 1909 to 1910 I became familiar with the apparatus used by the Signal Corps from the very earliest days of radiotelegraphy.

From 1911 until 1913 I was attached to the Army Signal School as an instructor—first as the instructor in charge of the practical work in the laboratory, and during the year 1912 as instructor in the theory of radiotelegraphy. During my tenure of office as instructor I was constantly engaged in experimental radio work, as well as in the practical operation of radio stations. During that period I took the examination for a first grade commercial operator's license and obtained such a license. During that period also I wrote several papers for the scientific press, one of which was copied by the London Electrician and had to do with the coupling function in receiving circuits. I also prepared for the Signal Corps a small volume on the uses of the wave meter in wireless telegraphy which in 1913 I had published for commercial use. While I was not an officer of the Signal Corps while at the Army Signal School, I was, nevertheless, doing nothing but Signal Corps work, and more particularly radio work.

During the year 1912 I was sent on a trip to Fort Riley, Kans., to assist in the installation of the first quenched spark transmitter on an Army aeroplane and to make tests of this apparatus in conjunction with the aeroplane control of artillery fire.

Due to the operation of the so-called Manchu law I was obliged to join a regiment of infantry in the early part of 1913 and was ordered with my regiment to Galveston, Tex., where a force of troops had been gathered pending certain happenings in Mexico. While at Galveston, I un-

officially assisted in the radio work of a signal company camped at the same place. About October, 1913, I was ordered to the Philippine Islands where I was stationed at Corregidor Island, Manila Bay, and notwithstanding the fact that I was nominally an infantryman I was loaned by the Infantry to the department signal officer, Manila, to assist in the radio work of the Signal Corps.

[fol. 893] Primarily in the work of revamping the big Corregidor radio station, installing new antennae, designing and installing a new counterpoise system, supervision of the erection of an additional 250-foot tower and the installation of new transmitting and receiving devices in the station itself. I was also called to Manila upon the arrival of each transport to inspect and install apparatus and make changes in the radio apparatus of each transport, as well as to tune and check the tuning of the interisland transport fleet. Early in 1914 I built and used in a plane the first receiver which actually received a message on an Army aeroplane from a radio station on the ground.

From 1914 to 1915 I was stationed in the city of Manila itself, and from 1915 to the latter part of 1916, at Fort McKinley, a short distance outside of the city of Manila, during which two years I continued to serve the Signal Corps in an unofficial capacity in connection with radio operation, as well as carrying out my duties as an officer of Infantry.

In September, 1916 I was detailed as captain of the Signal Corps, and ordered to Fort Leavenworth, Kans., as acting commandant and instructor at the Army Signal School, where I stayed until the latter part of 1917, carrying on experimental radio work, instructing in radio and hurriedly organizing during the last month or two signal troops for the Great War.

In the latter part of 1917 I was ordered to duty in the office of the chief signal officer at Washington, D. C., for a month or two in charge of training, then being assigned as officer in charge of the electrical engineering division, which for a few months was entirely separate from the radio division under Major Slaughter.

Early in 1918 I was placed in charge of the entire engineering and research division, in which were consolidated the radio and the electrical engineering divisions. My duties involved, among other things, passing upon engineering questions concerned with the development of radio

and other apparatus. While still on this duty in 1919 I was taken overseas by General Squier, then the chief signal officer, and had a chance to observe the field and fixed radio stations of our own and the allied troops in France and Germany. Before returning home I was accredited as a delegate from the United States to the first Allied Radio Conference, held in Paris. I then returned to the United States and continued my duties as chief of the engineering and research division, and during the period immediately following the conclusion of the war was associated with General Squier, Doctor Cohen, and Captain Hill, radio corps, in a large amount of experimental work, in which I took a practical part. For example, General Squier's experiment on wired wireless, tree telegraphy, the transmission of radio over bare wires laid in the water, and a number of experiments with resonance wave coils resulting in the filing of more than 20 patent applications with one or more of the gentlemen named, both in the United States and foreign countries.

In 1921 I was sent as a representative of the United States to the Inter-Allied Provisional Technical Committee of the International Communications Conference held in Paris, France. Upon my return from abroad in 1921 I was transferred from Washington to Chicago, Ill., where I performed the duties of corps area signal officer, in which [fol. 894] position I controlled and assisted in installing a number of radio stations of the Army within the Sixth Corps Area.

During my stay in Chicago I performed some further experiments in wired wireless at the direction of the Chief Signal Officer of the Army. After a year and a half in Chicago I was ordered back to Washington, D. C., with station at the Bureau of Standards, where I am at present nominally the commanding officer of the Signal Corps radio-laboratory, but practically engaged in experimental and research work entirely of a radio character.

Last summer, 1924, I was sent as a technical adviser to the delegation from the United States to the Pan-American Communication Conference held in Mexico City, Mexico, for two months or more. At the close of the conference I returned to my laboratory work at the Bureau of Standards. Shortly after the beginning of this present year, in addition to my duties at the Bureau of Standards I was appointed as Army liaison officer with the Naval Re-

search Laboratory, Bellevue, Anacostia, D. C., where I am also engaged in laboratory work, entirely along radio lines. At the present time, two days a week are spent at the Bureau of Standards laboratory, and four days a week at the Naval Research Laboratory.

2. Question. What are the relative advantages or disadvantages of connecting a detector at a receiver or spark gap at a transmitter in the antenna circuit, so that one terminal is connected to the antenna and the other to the earth, as illustrated, for example, diagrammatically at G and T in the schematic diagram of Marconi Reissue 11913 at the left hand side of plaintiff's Exhibit No. 99 on the one hand, and connecting the detector at the receiving station and the spark gap at the transmitting station in a lateral circuit inductively coupled to the antenna, as illustrated diagrammatically, for example, in the diagram Wireless Specialty Apparatus type, plaintiff's Exhibit 87, or for example, in the diagram, Foote-Pierson pack set, plaintiff's Exhibit 102?

Answer. Referring to Figure A, plaintiff's Exhibit 99, the left-hand figure illustrates a spark-gap transmitter in which one terminal of the gap is connected to an elevated capacity area f , and the other to ground or earth at c . The only known advantage that such a transmitter had was its ability to create highly-damped disturbances in the ether such as would be desirable in the case of distress messages so that a maximum of interference to radio communication might be brought about and attention attracted to the distress signal. In touching upon its sole advantage I have pointed out its great disadvantage for practical radio communication—namely, its high damping—resulting in unreasonable interference. Comparing this diagram with plaintiff's Exhibit 87, the left-hand figure, and with the left-hand figure of plaintiff's Exhibit 102, both of which indicate a coupling between the primary and secondary circuits, the latter two circuits employing a means for coupling the primary circuit to the antenna, represent a considerable advance in the art over the apparatus employed in Figure A, plaintiff's Exhibit 99, before referred to. This advantage lies in the fact that selectivity results from the use of coupled circuits, for where energy produced in the lateral circuit which is comparatively highly damped, can be communicated through proper coupling to an antenna system of much lower damping, the energy will be radiated from

[fol. 895] the antenna in purer form on a sharp wave in such a manner as to comply with the present law of the United States which require that the damping of the transmitter shall not exceed 0.2. The plain spark-gap apparatus illustrated at the left hand of plaintiff's Exhibit 99 (Marconi reissue 11913, 1896) can never be arranged to have so small a damping. Practically the employment of a circuit at the transmitter permits of the radiation of a single sharply tuned wave capable of giving the minimum amount of interference from such a spark system.

Referring now to the right-hand figure of Figure A, plaintiff's Exhibit 99, which indicates a receiving station where an imperfect contact device or coherer has one of its terminals connected directly to an elevated capacity area, its other terminal being connected to earth, and having further reference to plaintiff's Exhibit 87, the right-hand diagram of which indicates a coupled circuit receiver having a detector in a lateral circuit in inductive relation with an antenna circuit, and having reference also to plaintiff's Exhibit 102, the right-hand figure, illustrating also a receiving station having a lateral detector circuit inductively coupled to an antenna system comprising an inductance and antenna and an earth connection, again as in the case of the transmitter shown in plaintiff's Exhibit 99, lack of selectivity follows the use of a detector placed directly in the antenna circuit, as compared with the coupled receiving circuits illustrated in the right-hand figures of plaintiff's Exhibits 87 and 102, respectively.

This question of selectivity is one of the most important practical questions in radio communication. The ability to loosely couple the lateral circuit with the antenna circuit permits us to sharpen the tuning with reference to the station which we desire to receive; in other words, to select and receive without interference the signals from a certain station without interference from stations operating on a wave length fairly close to the station which we desire to receive. In a word then, low damping and selectivity are gained by using loose coupling in both transmitter and receiver circuit.

3. Question. What can you say as to the commercial importance and extent of use of connecting the detector at the receiver or the spark gap at the transmitter in the antenna circuit, as indicated in the Exhibit 99, left-hand figure, as compared to connecting the detector in a coupled

lateral circuit, as indicated in plaintiff's Exhibits Nos. 87 and 102?

Answer. The use of the spark gap directly in the antenna as compared with the use of a spark gap in a lateral circuit coupled to an antenna system from a commercial standpoint can scarcely be compared, for it was so early found that selectivity was essential and that the spark gap in the antenna failed to provide such selectivity that its use amounts to practically nothing, as compared with the use of the coupled circuit transmitter affording far greater selectivity. So far as the Signal Corps is concerned, I saw but few types of apparatus employing a spark gap directly in the antenna, ever even offered for test to the Signal Corps. Similarly, with reference to the receiver, the use of a circuit in which the lateral detector circuit was coupled with the antenna circuit has been almost universal, both in commercial and Army practice. In connection with some later testimony, I shall introduce in evidence some [fols. 896-897] official documents from the War Department showing the widespread use of apparatus from the very earliest days employing these coupled circuits.

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7. Question. Will you refer to the defendant's Exhibit R-4, Loftin sketch A, and to the defendant's Exhibit B-4, Inventions, Researches, and Writings of Nikola Tesla, and say whether in your opinion the Tesla article describes and illustrates in Figures 165 and 185 the subject matter of said Sketch A?

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Answer. Having reference to the second figure from the left, or more properly speaking, the second circuit from the left, illustrated in Figure 165, I find that the organization of a transformer T having a primary supplied with power from an alternating-current generator G , said transformer T having its secondary windings S shunted by a fixed condenser C , said condenser C also forming part of what is known in the radio art as a closed oscillatory circuit comprising an inductance P and two spark gaps, the terminals or electrodes of which gaps are each marked d , and in inductive relation with another circuit consisting of an inductance S_1 , each end of which is supplied with a conductor leading to something not shown in the diagram, Figure 165, corresponds exactly to the organization shown

in Exhibit R-4, otherwise noted as "Loftin sketch A," Tesla transmitter, with the exception of the fact that the secondary S_1 in Exhibit R-4 is connected to a capacity area P and an earth connection E. Considering also Figure 185 and the accompanying description on the same page, namely 348, *Inventions of Nikola Tesla*, I find that Tesla has described what might be termed a coupled circuit spark transmitter capable, if actually set up to-day, of transmitting radiotelegraphic signals of damped type. That Tesla actually foresaw what this device would do is evident from the language employed on page 348 referred to. He assumes a source of high-frequency alternating current connected to an elevated body of large surface P which corresponds exactly to the horizontal part of a modern antenna system, while the lower part of the source S_1 is connected to earth, as in previous pages of the book now under consideration; and with particular reference to Figure 165, as he has indicated in the text that any one of the sources [fols. 899-900] of high-frequency alternating current may be utilized in this connection, I am of the opinion that Mr. Tesla not only foresaw that his apparatus would result in the actual propagation of radio signals but he has also described how at a distance a similar apparatus comprising an elevated conductor of large surface connected through a suitably tuned circuit to earth could be utilized to receive the energy from the transmitter such as assembled by Loftin in Exhibit R-4, from a consideration of the Figures 165 and 185. Quoting this article, the writer states:

"When the electrical oscillation is set up there will be a movement of electricity in and out of P and alternating currents will pass through the earth converging to or diverging from the point C where the ground connection is made. In this manner neighboring points on the earth's surface within a certain radius will be disturbed. But the disturbance will diminish with the distance and the distance at which the effect will still be perceptible will depend on the quantity of electricity set in motion."

He then goes on to describe the tuning organization necessary to effect the reception of signals from the transmitter described, as follows:

"Now, it is quite certain that at any point within a certain radius of the source S, a properly adjusted self-induction and capacity device, can be set in action by resonance."

While Mr. Tesla's conception of the transmitter shows that he thought the earth necessary, as Marconi did, for the transmission of energy to distant points on the earth's surface, there to be received by a synchronous device consisting of an elevated capacity area of vertical wire connecting the same to tuning elements consisting of self-inductance and capacity and a suitable earth connection for the purpose of receiving and reradiating in the case of his power experiments the energy supplied from the original transmitter, nevertheless he has described in the parts of the book quoted a perfectly operable transmitting system with suitable tuning devices and with a suitable receiving device having tuned circuits. Whether Mr. Tesla intended to tune the closed circuit C-d-P to the open radiating system P-s-l-E illustrated in the combined sketch of what he proposed, Exhibit R-4, so that both circuits had the same time period of oscillation, or whether he intended to excite the antenna system, as we may call it, in a harmonic relation, is not known. That, however, is immaterial. He appreciated the necessity of synchronism and he taught the use of coupled circuits long before Marconi or Lodge.

I forgot to note that in both Figure 165 and Exhibit R-4 a switch is provided between the source of alternating current G and that primary of the transformer, T; the diagram shows in both cases that both circuits may be interrupted so that signals could be sent with such a device whether only one blade of the switch were opened or both, thus affording a complete system for the transmission of radio signals.

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[fol. 901] 10. Question. What are the relative differences and advantages of the type of transmitting apparatus illustrated in plaintiff's Exhibit 87, wireless specialty type, employing a quenched gap, as compared with the open-gap, loose-coupled type of apparatus, illustrated at the right of plaintiff's Exhibit 99, Marconi 763772?

Answer. Referring to the type of transmitter shown at the right of plaintiff's Exhibit 99, Marconi 763772, I find an arrangement of circuits in which the primary transmitting circuit consists of a spark gap G, a condenser *c*, and an inductance of very few turns. This inductance is in relation with an inductance of more turns than that in the primary transmitting circuit and is referred to in the

figure as d' . This coupling inductance in the secondary or antenna circuit has one end connected to earth and the other end is connected to a variable contact l on a loading coil g , the upper end of which is connected by wire to an elevated capacity area f . Without referring to Marconi patent specification, my understanding is that what he was trying to accomplish was to secure the loosest possible coupling between the primary and the secondary circuits which would give him the most efficient radiation on a single wave from his antenna. In order that his primary circuit might be a persistent oscillator, he made the capacity c as large as possible and the inductance as small as possible for one reason so that the coupling between the primary and the secondary circuits might be reduced to the smallest practical value and still transfer energy to the antenna system which he loaded and adjusted to the period of the primary circuit by putting more or fewer turns between the variable contact l and the lead to the antenna. Moving this contact l had the effect not only of varying the time period of oscillation of the antenna circuit but also in a certain degree varying the coupling between the two circuits. By the arrangement described the primary circuit became a reservoir of energy which was slowly fed to the antenna with very loose coupling so that the energy in the antenna might be radiated most efficiently and not re-transferred to the primary circuit, as would be the case if anything but the loosest coupling were employed in such a system,

[fol. 902] The desire was to secure the transmission of a wave having but a single frequency which was determined practically by the adjustment of the primary circuit. The energy in the antenna persisted only as long as the oscillations in the primary circuit existed. This I know is not in accordance with the idea introduced by Mr. Waterman, as illustrated in Waterman's sketch No. 2, which to the average student of the radio art is a diagram showing what happens not in the open-gap type of transmitting apparatus but what happens practically in the quenched-spark type of apparatus where in a very short period of time, practically when the first beat occurs between the primary and the secondary circuits, the energy in the antenna circuit persists for a long time while the energy in the primary or exciting circuit is wiped out after the first beat in practice. This does not accord with Mr. Marconi's

idea that his primary circuit must be a good reservoir to keep feeding energy to the antenna circuit. In the apparatus arrangement shown in the plaintiff's Exhibit 99, the left of Figure C, the desire of the inventor was to keep supplying energy just as long as possible from his closed circuit to his open circuit, whereas in the quenched-spark circuit, plaintiff's Exhibit 87, where a quenched-spark gap is employed, the object is to transfer the energy from the primary circuit in an extremely short time, open that circuit at the spark gap automatically after the energy is all transferred to the antenna system at the first beat, and let the antenna circuit continue to oscillate in its own time period of oscillation.

Referring now to plaintiff's Exhibit 87, diagram of the transmitting station, we find a somewhat different arrangement with respect to the gap employed and the coupling between the circuits, as illustrated in the diagram by the fact that there are more turns in common, more linking of lines of force--in other words, tighter coupling between the primary and secondary circuits than is desired to be obtained in the apparatus shown in plaintiff's Exhibit 99, Marconi 763772, at the left of Figure C. This desire for loose coupling in one case and close coupling in the other is what determines the principal difference between these arrangements. In the Marconi arrangement the pace-setting circuit is the primary circuit, whereas in plaintiff's Exhibit 87, diagram of transmitting station, the pace-setting or frequency-determining circuit is the antenna circuit. In the latter circuit it is entirely desirable, as before stated, that the energy be transferred as rapidly as possible from the closed oscillatory circuit to the open oscillatory circuit. The latter arrangement, that of the Wireless Specialty Apparatus Co., or the quenched-spark transmitter, which, by the way, furnishes excitation and which has been aptly termed "impulse excitation," has many advantages over the Marconi type of transmitter which caused it to supersede the plain spark-gap type of apparatus. In the first case of the Marconi apparatus a tremendous amount of the energy developed is wasted in the primary circuit where at the gap noise, heat, and light are produced and where the resistance of the circuit as an oscillatory circuit is comparatively so high that an immense amount of work must be done on that primary circuit itself, leaving less energy to be transferred to the antenna circuit to be used in useful

radiation, whereas in the quenched-spark type of apparatus the gap, due partly to its peculiar arrangement and construction and principally to the critical degree of coupling [fol. 903] employed between the primary and the secondary circuits, ceases to operate after the first beat when the energy in the primary circuit has fallen to zero and that in the antenna has risen to maximum, leaving the antenna circuit free to dissipate this energy as useful radiation, with the result that the energy was transmitted in practice to much greater distances with the quenched-spark apparatus employing a given amount of power in the input as compared with that distance which could be obtained by transmitting from the Marconi type of loosely coupled transmitter with the same power applied to the input. It is very interesting to note in this connection that there was a good old thumb rule that with one kilowatt in the input of a well-adjusted Marconi plain gap transmitter the distance obtainable in the daytime over the sea could be counted on as a hundred miles, whereas with the same input a quenched-spark transmitter with the same height of antenna when properly adjusted would give a range of 200 to 300 miles in daylight over the sea. I have made this comparison myself of the efficiency of the two types of transmitter, observing that with a given antenna, if four to six amperes could be put into the antenna circuit with the open-gap transmitter into the same antenna with the one kilowatt Telefunken quenched-gap set, I have put 15 amperes into the antenna. The Telefunken company claimed an over-all efficiency of 75 per cent, but in practice we figured the efficiency from prime mover to antenna was roughly 50 per cent—decidedly higher than ever could be obtained with the Marconi type of open-gap transmitter. The principal advantages in favor then of the quenched-spark type of apparatus was the fact that the over-all efficiency was much higher, the damping of the system much lower, the oscillations in the antenna more persistent, giving cumulative results at the receiving station, enabling better reception at longer distances to be carried out or obtained.

I should like to continue my testimony with reference to that particular question. In a loosely coupled circuit of the Marconi type, unless the circuits are closely coupled, beats do not occur as in the case of the quenched-gap sets between the primary and the secondary circuits, as they do

happen in a quenched-spark set when the circuits are necessarily tightly coupled. In practice we have found that the coupling in a quenched-spark transmitter must be about 20 per cent, but in the case of the quenched-spark transmitter it is to be noted that, due to the quenching action, even with this close coupling a wave of only a single frequency is produced, whereas if the open gap Marconi type of circuit were used with a tight coupling of say 20 per cent, two widely separated humps would be radiated or noticed with a wave meter as well as two widely separated frequencies received at the receiver from such a tightly coupled Marconi transmitter. To repeat what I was saying about Mr. Waterman's sketch No. 2, I intended to convey the idea that that diagram closely resembled a diagram showing what happens in a quenched-spark set and also indicating that this is not my understanding of what occurs in the Marconi type of transmitter when loose coupling is employed and where, as may be shown by diagrams from well-known text books, the energy in the primary is never reduced to zero, nor does the gap cease functioning before the energy in the antenna is completely radiated.

[fol. 904] 11. Question. In practice how are the two types of apparatus above referred to calibrated?

Answer. In the case of the Marconi transmitter, by coupling the wave meter to the primary circuit and at the same time disconnecting the antenna and the ground from the antenna coupling coil and loading coil, if one be used, the primary circuit is excited and measurements made of the frequency or wave length turn by turn, as the inductance in the circuit is increased from a minimum to a maximum value. A table can be made or preferably a curve plotted showing the wave length corresponding to the various turns of the inductance. This curve, then, is a calibration curve of the primary circuit and enables the operator to determine at once what adjustment of the primary circuit is necessary in order to give a certain chosen wave length. To measure the antenna circuit, the antenna and ground are connected to the inductances while the coupling between the primary and secondary is kept at zero and the spark gap not actuated. A detector of the crystal type may be shunted around the antenna inductance which forms part of the coupling system and with a pair of telephone receivers shunted around the detector a wave meter using buzzer excitation may be used to excite the aerial, and as the

inductance in the antenna is varied turn by turn from no turns up to a maximum the wave length of the antenna system can be determined for each adjustment and another curve plotted, preferably on the same sheet as that on which the primary circuit calibration was plotted, with the result that the operator is now in a position to choose from his curves the exact adjustments necessary in each circuit so that the circuits may be adjusted to emit a wave of given frequency provided the coupling between the primary and the secondary circuits is maintained at a very small value, for in this case only with very loose coupling can the circuits be put in inductive relation with each other and be expected to emit but only one frequency. The law of the United States requires that transmitters of this sort, due to their bad adjustments in the early days, be so coupled and adjusted that they shall emit a pure wave; that is, a wave of a single frequency and without harmonics, and that the transmitter shall have a decrement, or emit a wave having a decrement of not over 0.2.

We must now consider how the operator goes about securing the emission of as pure a wave as possible. As I before described, the circuit which is the pace setter with this particular arrangement is the primary circuit. If tight coupling takes place, two waves are emitted, neither of which has the frequency of the wave to which the primary and the secondary circuits were both originally tuned. The operator therefore having the constants of the two circuits adjusted so that the product of L and C in the case of the secondary equals of the product of L and C in the primary circuit, the coupling between the two circuits is gradually increased until the energy transferred to the antenna is a maximum, while the wave meter in suitable proximity to the antenna circuit but not coupled to the loading coil indicates the existence of but a single humped resonance curve which meets the requirements laid down by governmental regulations. Such calibration should necessarily include the measurement of the decrement to be sure that the transmitter stays within but 0.2 prescribed by law. Now, in the case of the calibration of a quenched-spark transmitter, due to the peculiar difference between such a [foi. 905] transmitter and the open-gap type of Marconi transmitter, calibration can not be accomplished quite in the same way as that prescribed. What the operator really needs to know in this case is the adjustment he must make

in order that when real quenching takes place in the gap a wave of a certain definite frequency or length, say 600 meters, will be emitted from the set. Likewise, he wants to know what adjustments in turn he must make so that waves of 700 or 800 meters may be radiated with a maximum efficiency. In this case it is highly essential that the calibration of the antenna circuit be accurately determined, since in this case it is this circuit which determines the frequency of the radiated wave. The method for determining the wave lengths corresponding to the various settings of the inductances in the antenna circuit may be determined practically along the same line as outlined for the calibration of the antenna circuit of the plain gap transmitter; that is, by using the antenna circuit as a receiving antenna to which is connected around a few turns of the inductance a crystal detector shunted by a pair of telephone receivers with which signals are received from a buzzer-driven wave meter and the wave length or frequency corresponding to each setting of the loading coil or other antenna inductances noted and then plotted in the form of a curve, if necessary showing what adjustments in the antenna are necessary to have that antenna oscillate at any given frequency.

The secondary circuit throughout these measurements has been completely separated from the antenna circuit so that there shall be no mutual inductance between the two. It is not absolutely essential that we calibrate the primary circuit, although this may be done with a view to determining about what adjustments are necessary so that a wave of given length may be emitted by the primary. Such calibration would be of little use if we were then to couple together the primary and the secondary circuits with say 20 per cent coupling, which is approximately the amount needed for the proper operation of a quenched-spark transmitter if the quenched spark replaces the open spark. What practically happens is that the primary circuit is adjusted for a given wave length and the secondary circuit, more or less in tune with the primary, is given the proper degree of coupling with the primary, and then final adjustments are made for the critical coupling necessary, as well as for the final determination of the frequency of the primary circuit, necessitated by such close coupling in order that when the energy is transferred from the primary to the secondary circuit proper quenching may take place and but a single wave of very low damping be emitted. This last adjustment

may cause the primary and the secondary to be slightly out of tune with each other, as can be demonstrated by a measurement of the primary if the antenna and ground be disconnected.

So therefore a table of adjustments for various frequencies or wave lengths can only be correct if the practical degree of coupling can be determined and recorded. We might even say that with a quenched-spark set, that there really is only one circuit oscillating when efficient radiation is taking place, because, due to the fact that beats take place between the currents in the two circuits while the energy is being transferred from the primary to the secondary circuit when the proper coupling has been [fol. 906] found, the energy in the open circuit will be found to be a maximum when the energy in the primary or closed circuit is found to be a minimum and the gap ceases to function when the first beat takes place and the energy in the antenna due to radiation and other causes is gradually dissipated, but making many more swings or oscillations before the current in the antenna is reduced to one-tenth of its maximum value than can ever hope to be produced by means of the Marconi open-gap transmitter.

12. Question. In the next to the last paragraph of your last answer beginning "The secondary circuit through etc.," you used the term "secondary circuit" and "primary circuit." Will you please read over this part of your answer carefully and indicate whether these terms in this part of your answer are intended to indicate the antenna circuit or the lateral circuit?

Answer. As I have been considering only the transmitter, the term "primary circuit" is used to indicate the lateral circuit, and the "secondary circuit" in this case is to be understood to mean the antenna circuit. I see that I have made an error and said something which I did not mean in the second line of the second paragraph on page 1038, where the word "antenna" should read "primary." Likewise, I notice another error which I request corrected—the word "primary," seventh line, second paragraph, page 1038, should read "secondary." I notice other errors, and I request that the second paragraph on page 1038 be rewritten to read as follows:

"The secondary circuit throughout these measurements should be completely separated from the antenna circuit so that there can be no mutual inductance between the

two. It is not absolutely essential that we calibrate the primary circuit, although this may be done with a view to determining about what adjustments are necessary so that a wave of given length may be emitted by the secondary. Such calibration would be of little use if we were then to couple together the primary and the secondary circuits with say a 20 per cent coupling, which is approximately the amount needed for the proper operation of a quenched-spark transmitter. What practically happens is that the secondary circuit is adjusted for a given wave length and the primary circuit, more or less in tune with the secondary circuit, is given the proper degree of coupling with the secondary and then final adjustments are made for the critical coupling necessary, as well for the final determination of the frequency of the primary circuit, necessitated by such close coupling, in order that when the energy is transferred from the primary to the secondary circuit, proper quenching may take place and but a single wave of very low damping be emitted. This last adjustment may cause the primary and the secondary to be slightly out of tune with each other, as can be demonstrated by a measurement of the primary if the antenna and ground be disconnected."

13. Question. What has been the extent of use in the wireless art of the two types of apparatus referred to in question 10?

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Answer. So far as the Army is concerned, once the efficiency of the quenched-spark transmitter as compared with the open-gap Marconi type of transmitter was demonstrated, the Army as fast as governmental appropriations allowed, started to install in both its fixed and mobile stations apparatus of this type. The reason that there are [fol. 907] still in existence a number of the old open-gap Marconi transmitters is probably a question of funds on the part of shipowners who still cling to this old type of apparatus because they can not afford to make replacements. The fact that the Marconi company itself saw the advantages of the quenched gap is evidenced by the fact that they manufactured sets of this type such as that furnished to the Signal Corps, and referred to in my answer to question 9. My general impression is that as far as possible, considering the patent situation, the quenched-spark

gap was installed in preference to the Marconi open type of gap set in the commercial field, as well as in the Army and Navy, which, it must be pointed out, have in this country been two of the biggest factors in the development, use, and encouragement of radio that the country has ever known. I may add that these quenched gaps were usually supplied with 500-cycle generators, which produced a musical spark which was much better for the receiving operator, since he could read it with greater ease through static than he could a low rumbling note of the spark sets of Marconi type which were not at all easy to read through even a small quantity of static when separated very far from the receiver. I should also like to point out other advantages which induced commercial companies such as shipowners to purchase quenched-spark apparatus. Among other things it was found that with the Marconi type of transmitter, due to the type of transformer employed and the nature of the circuits themselves, as well as the kind of gap employed, high voltages were set up which had a tendency to break down antenna insulators and generally develop insulation faults, whereas with the quenched-spark type of transmitter the voltages developed were comparatively lower with decreasing losses due to broken insulators and other ruptured insulation. For these same reasons the Army and the Navy adopted the quenched-spark gap about the year 1909, as I have before pointed out.

14. Question. Will you refer to Figure 1 of the Fleming patent 803684 and state whether or not two-element vacuum tubes, such as illustrated in this figure, for example, have been used in practice in the Signal Corps, so far as you know?

Answer. To the best of my knowledge and belief, the Signal Corps never has had one of these tubes operating at any time in any of its circuits. The device apparently offered no advantages over the instruments in use, and while I am quite satisfied that our radio engineers were cognizant of the ~~trials~~ trials of this detector elsewhere, none was ever purchased for use in the Signal Corps.

15. Question. What type of vacuum-tube device has the Signal Corps always used, so far as your knowledge goes.

Answer. The Signal Corps has always used a three-element tube, and as I have been with the Signal Corps ever since the first tubes were used I feel that I have first-hand knowledge of the various types of tubes, or, I should

say, various makes of tubes of three-electrode type, which have been put into practical use in the Army of the United States.

16. Question. Will you give a brief historical statement indicating the development of the wireless art and the chronological introduction of important development?

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[fol. 908] Answer. As I look back over the period from 1899 to the present day, during which period I have been in touch with the development in the art of radiotelegraphy, partially through the reading of literature, the study of text books, the examination of apparatus submitted to the Government department by various native and foreign commercial concerns, there are certain outstanding steps of progress marking epochs which we are better able to evaluate looking backward than we could at the instant of the development of each. The contribution of Mr. Marconi in gathering together and combining in a working apparatus the coherer of Branley and the receiver of Popoff together with the transmitter of Hertz, as put into practical form by Tesla, formed the first step in the practical system about the year 1896. The introduction by Lodge of tuning elements was the next step, which at that time, looking forward instead of backward, appeared to be a wonderful advance which Marconi was glad to incorporate in his four-circuit patent to a certain extent, but which syntonie arrangements had been described before by Tesla and others. The Signal Corps itself was not behind in the development of radio. The development of radio in the Signal Corps in its early days can be shown by extracts from the report of the Chief Signal Officer, and it is interesting to note from these reports that in the year 1901 he states, "In wireless telegraphy the Signal Corps has perfected its own system, which was the first one ever successfully operated in the United States, on September 30, 1899, between Fire Island and Fire Island Lightship, a distance of 10 miles."

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Continuing with reference to extracts from the report of the Chief Signal officer of the Army indicating how the art developed a perusal of the reports for the years 1901, 1902, 1903, and 1904, shows the early efforts of the Signal Corps to established communication over a distance of ap-

proximately 100 miles in Alaska, and how the Signal Corps attempted to make contracts for Fessenden and Marconi apparatus which would give them effective working at this distance, or similar distances; how the DeForest system was used during the Army and Navy maneuvers on Long Island in the year 1903, the messages being received by telephone and the De Forest responder. An interesting extract from the report of the year 1904 is the following:

"Owing to the repeated failure of several wireless telegraph companies to furnish a reliable and satisfactory system of wireless telegraphy in Alaska over a distance of 100 miles, the Chief Signal Officer decided in 1903 to have all existing systems examined with reference to their practical qualities. He decided to obtain by elimination, substitution, or invention some system for Army use which would embody qualities necessary for the reliable and successful transmission of messages."

[fol. 909] This report is practically a résumé of what was done from the year 1899 to the time the report was written and shows that the Signal Corps tested a Braun-Halske field wireless train and that—

"Experiments were carried out under Captain Wildman's personal supervision during the past year with instruments purchased from: the Lodge-Muirhead Wireless Telegraph Co. (Ltd.), of Great Britain; the Braun-Siemens-Halske Wireless Telegraph Co. of Germany; the National Electric Signaling Co., of Washington; and from the De Forest Wireless Telegraph Co. of New York.

"Experimental apparatus were purchased by the Chief Signal Officer from time to time in addition to the instruments furnished by companies and individuals; comparative tests were also made with all obtainable receivers, responders, and coherers on the market as well as with many different types of special appliances, particularly those in the Stone-Stone system.

"Notwithstanding the popular idea with wireless telegraphy over great distances is an accomplished fact, none of the systems investigated proved satisfactory for Army use."

"This is a commentary on the state of the art for the year 1904, where manufacturers could not be found who could furnish apparatus satisfactory to give communication at 100 miles.

The Signal Corps then from the record, supported by the photographic evidence already introduced, being Exhibit No. H-5, developed its own system, employing an open-spark set with linking coils or leading coils for tuning purposes in both transmitting and receiving circuits. The detectors used were practically all the electrolytic type until the crystal detector came into general use because of its decided advantages about the year 1906. This practice of substituting crystal detectors for others was not confined to the Army and Navy of the United States, but spread rapidly all over the world in commercial as well as governmental practice. A real step in the wireless art was taken when the efficient quenched-gap apparatus came into use in 1909. The advantages of this apparatus over the open-spark type of apparatus have been pointed out before, namely, higher overall efficiency resulting in greater distances, the radiation of a pure single wave instead of the highly damped, that is to say, comparatively highly damped, waves of the old spark-type transmitter.

Quite another distinct step of importance occurred about 1913 with the introduction of continuous-wave telegraphy, and while various advances have been made in this art by the introduction of the arc, the alternator, and means of reception for continuous waves, nevertheless the greatest progress ever made in the art of radiotelegraphy was the introduction of the three-electrode vacuum tube, about which the whole radio art to-day revolves. The enormous progress in radio since its introduction far outshadows not only the work of Mr. Marconi but Hertz himself. The advance made by Mr. Marconi over his predecessors, including Hertz, can not in any way be compared to the wonderful advance made by the introduction of the three-electrode tube. To-day we find tubes of 80 kilowatts being manufactured for transmission purposes. The whole real practice of radiotelephony has grown up about this tube, and because of its amplifying power it in turn made possible generation of high-frequency oscillations not obtainable by any other method. The arc and the alternator had their place, but the frequencies which they could use were so limited [fol. 910] with reference to those which can be produced simply by the three-electrode vacuum tube that we can almost say that radio was really born when the three-electrode tube arrived.

As for the remarks made by counsel for the plaintiff regarding my competency as a witness concerning the progress of the art, outside of what was done by the Signal Corps, I should like to state at this time that my observations as to actual transmission and reception systems has by no means been confined to the apparatus and stations used by the Signal Corps. I have seen many commercial ship and shore stations, and it is interesting to note that the only time I ever saw a two-electrode Fleming valve was in the Marconi station located in the Wanamaker Store, New York City. It is also interesting to note that on this occasion the receiver used contained two of these vacuum tubes. The most interesting thing in connection with this visit was the fact that the operator was using a crystal detector instead of the vacuum tube for receiving from Philadelphia. About the same time I had occasion to visit the De Forest station in this city and the station, which I believe was Marconi, established on the Waldorf Hotel. During the course of my official duties, as I have stated, I have seen many commercial stations not only in America but in Mexico, France, Germany, and England. In addition, I have paid visits to many of the wireless telegraph and telephone stations established in this country. While visiting the stations at Nauen, Ste. Assize, Bordeaux, Lyons, the Eiffel Tower, and both commercial and governmental stations in England as well as in Mexico, I have been accompanied by some of the greatest radio engineers in the world, who have carefully gone into explanations concerning the apparatus and connections used in each case. Hence I believe that I am quite well qualified to talk about the facts connected with radio development in the commercial world. In my position as executive officer of the engineering and research division of the Signal Corps for four years, it was my duty to visit practically all of the manufacturing plants of radio apparatus in the United States in which I have followed the progress of the art by an examination of the apparatus which they were building, some of which was later used by the United States and a great part of it by commercial companies.

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17. Question. Is the two-electrode vacuum tube inherently capable of either amplifying or oscillating?

Answer. The two-electrode tube is not inherently capable either of amplifying or oscillating. I have made some ex-

periments bearing on the subject as to whether or not the two-electrode tube will oscillate or amplify, and, leaving aside for a moment consideration of the question as to why the two-electrode tube has not the inherent qualities of amplification in the production of oscillations, I wish to state something concerning the experiments which I have performed to determine the oscillating and detecting qualities [fol. 911] of a two-electrode tube. It has not been my good fortune to be able to secure for examination any "soft" or gas filled two-electrode tubes made by the Marconi company. My examinations have been confined to the operation of a modern hard two-electrode tube, placed on the market about a year ago, for use as a detector only, and also to some old De Forest tubes of the type known as the "amplifier" tube, which was a tube produced by De Forest some time after his first "soft" audion detector tubes appeared on the market. By the time De Forest produced these tubes he had learned more about the art of producing a vacuum in the tube. Hence these tubes which I have examined are somewhat harder than the first tubes which he sold for detector purposes, but as his methods of pumping even then were not as good as they are to-day, these tubes which I have examined in some cases to which I will refer are what might be termed "semi-soft" or "semi-hard."

During the course of my experimental work I produced sketches showing Figures 1 to 8, inclusive, to which I shall refer in the course of my remarks. Using first the so-called "Diode" two-electrode tube placed on the market perhaps a year ago as a detector, I set up a circuit illustrated in Figure 1, marked "Mauborgne's sketches, Figure 1" in which a tuned oscillatory circuit consisting of inductance L and condenser C_2 which was variable is connected to a variable condenser C_2 through the plate P of the two-electrode tube, the other side of inductance L being connected to the filament at one point, the filament F being lighted in the usual way by a battery having a variable resistance in series for the control of the filament current. Telephone receiver T , as shown in the sketch, had one of its terminals connected to the same point of the filament battery while the other terminal of the telephones was connected to the minus terminal of the battery B , which could be varied from zero to 44 volts at will. The plus side of the B battery then passed, or was connected to, the high-frequency choke,

marked "HF choke," the other terminal of which was connected to plate P. The manufacturer stated that the filament current would be correct if one and a half volts were applied to its terminals; however, I varied the filament voltage from 1.3 to 4 volts and varied the B battery voltage from zero to 44 volts, and secured no oscillations of any character, the device simply working as a detector even with a maximum variation of voltages indicated. In this particular case the tuned circuit $L-C_1$ had its constants so chosen that the wave length could be varied from approximately 400 to 700 meters, while the condenser C_2 had a range varying from 0.00002 to 0.007 microfarads. This large range was not obtained with one variable condenser, but substitutions of condensers were made giving the range indicated. As the apparatus was connected to real antenna and ground, incoming signals were detected and it was found that for detection filament voltage should be $1\frac{1}{2}$ volts, but the most important thing that was discovered was the fact that as the voltage of the battery marked "B" was reduced step by step from 44 volts to zero, the detecting qualities of the circuit improved until it was found that the best signals were obtained when there was no "B" battery at all. Further elimination of the high-frequency choke, as would naturally be suspected, and the connection of the telephone T directly to the plate P gave the best received signals of all. It was to be noted that a considerable capacity existed across the telephone due to the particular kind of [fol. 912] jack used to connect the telephones to the rest of the circuit. Here at once we find one difference between this sort of two-electrode tube which in two ways can be identified as a very hard tube, and the three-electrode tube. I never yet have seen a three-electrode tube operated as such where the addition of a proper amount of "B" batteries did not increase the signal strength. It is to be noted that my Figure 1 does not differ materially from defendant's Exhibit "B," Fleming two-element valve. We know that this is a hard tube, because the magnesium flash used in the final stages of the evacuation of the tube is visible in the tube itself, and the fact that no blue glow or ionization could be obtained with plate voltage up to 44 volts is a good sign that it is a hard tube. The circuit shown in Figure 1 entirely disconnected from antenna and ground could not be made to oscillate.

In Figure 2, A shows the antenna, C_1 a series condenser connecting the antenna to the inductance L, the other end of which inductance was connected to ground G. C_2 , P, F, HF choke, B, and T are reference letters which pertain to similar elements already described in Figure 1. With the filament voltage varied from $1\frac{1}{2}$ to 4 volts and the plate voltage varied from no volts to 44 volts, the tube could not be made to oscillate.

Having reference now to Figure 3, the fixed high-frequency choke used in the two preceding experiments was replaced by a tuned high-frequency choke, marked in the drawing "Tuned HFC," consisting of inductance L_2 and C_3 , the constants L_2 and C_3 being chosen so as to cover the range of wave lengths known to be possible to receive with the antenna circuit. The other letters in this figure designate similar elements to those similarly marked in Figure 2. No oscillations could be produced in this case.

Having reference now to Figure 4, which is similar to Figure 2 with the exception that the "B" battery B and the high-frequency choke have been removed, and the terminal of the telephones, formerly attached to B, has been directly connected to plate P. This circuit was then used for the reception of distant signals in order to determine the comparative value of this two-electrode tube as a detector, since it has no other function with a crystal detector used in practically a similar circuit, illustrated in Figure 5, of Mauborgne's sketches.

In Figure 5, A, C_1 , L, designate the same elements used in Figure 2. D represents a detector of the iron pyrites variety which has been standing in the dust of the laboratory without cleaning for a number of months. T are the telephones, as in Figure 2. A comparison without an audibility meter showed that for given signals the detector of the crystal type was much superior to the two-electrode tube.

An audibility meter was then introduced, first in Figure 4 and then in Figure 5, or rather in the apparatus so connected, and measurements made on incoming broadcast signals, with the result that with the same signal an audibility of seven was secured for the two-electrode tube detector, as compared with an audibility of thirty for the Pyron detector, which is the trade name for the iron pyrites detector used. This demonstrates that a two-electrode hard tube is nothing but a detector, that it can not oscillate, nor, con-

versely, can it amplify. Also that as a detector it is far inferior to the crystal type of detector.

The next experiments were performed with an old De Forest semi-soft so-called "amplifier" tube having a Tungsten filament which the manufacturer stated could never be [fol. 913] operated with a greater filament voltage than $3\frac{1}{2}$ volts without threatening the life of the tube. In this experiment this De Forest tube was connected up in the circuit shown in Figure 6, where F is the filament of the tube, P represents the plate which in this case really consisted of the plate and grid of the three-element tube connected by a wire so as to form but one element. L_2 and L_1 are inductances variable in character, while C was a variable condenser covering a considerable range. This particular diagram is one described in British patent 72/08 (January 1, 1908), S. Eisenstein, shown on page 56 of Scott Taggart's book *Thermionic Vacuum Tubes* and described as being a method for producing oscillations with a two-electrode tube. Using a wide range of filament voltages, capacities, and variable inductances, both in L_1 and L_2 as shown in the diagram, no oscillations could be obtained. Coupling between L_1 and L_2 , variable in character, was tried without success.

In all the foregoing experiments a heterodyne wave meter near by, supplied with telephone receivers, was used to determine whether or not the circuits under test were actually oscillating or not. In a later test the exact circuit shown in defendant's Exhibit "B," Fleming two-element valve, was set up, and an antenna and ground connected thereto in the manner indicated in Figure 7 of Mauborgne's sketches. The only difference between this and Mauborgne's sketches, Figure 1, is the introduction of the variable condenser C_3 , so arranged as to shunt or by-pass the high-frequency choke, the B battery, and the telephones. In these experiments I used a three-electrode De Forest tube, which was known as the De Forest amplifier tube, $3\frac{1}{2}$ volts, Tungsten filament, and which as I have described, stands in an intermediate position between the early "soft" tube of De Forest and the very hard tubes of to-day. Some 25 tubes of this type were available, being fortunately found in the garret of the Bureau of Standards, where the obsolete apparatus has been lying for some time. Some of these tubes were found to be inoperative due to burned-out filaments. Ten good ones, however, were then taken for test and used in each case exactly as in Figure 7. The

values of L_1 and C_1 were so chosen that the circuit which they formed covered a range of from 400 to approximately 700 meters. Variable condenser C_2 had a maximum value of about 0.0016 microfarads, while the condenser C_3 had about the same maximum value. The high-frequency choke was the same one which was used in connection with the experiments described as relating to Figures 1 and 2. The B battery voltage could be varied from zero to 66 volts, while the filament voltage could be adjusted from 2 to 8 volts. With this circuit I succeeded in obtaining oscillations after the greatest possible difficulty experienced in adjusting B battery voltage and the filament voltage. I was able to obtain oscillations, however, over only a very limited part of the wave length range of the tuning system. Each time I threw the circuit out of adjustment and tried to get it to oscillate again caused me a considerable amount of fussing, indicating the unstability of the arrangement and its inoperability in the hands of the average operator. With the circuit oscillating as determined by listening in on a Navy type 1420-C receiver nearby, after a very short time in each case I noticed that the oscillations of the circuit would cease of their own accord. This could not in any way be imputed to the change in the batteries themselves or in their voltages, for I took the precaution to see that [fol. 914] I had new B batteries and storage batteries for the filament which were well charged. This instability then must be inherent in the tube itself, and undoubtedly is due to the varying condition of the gas in the tube. I have said in the beginning that these are semisoft tubes, and I am convinced that they fall in this class. The blue glow was set up in this tube, which I should have stated was numbered 17, when a plate voltage of 18 volts was applied, showing that this tube was comparatively soft. It was also noted that where after a good deal of struggling and most careful adjustment of filament and plate voltage that the oscillations occurred just about the place where the tube was about to show, or would show, a blue glow. Increasing the voltage of the B battery naturally stopped the tube from oscillating. As with the Diode tube in the earlier tests, when this De Forest tube with its grid and plate connected to form one plate was used as a two-electrode tube and actual signals were received, the signals were found to be a maximum and the detector action best when the B battery and the high-frequency choke were entirely removed and the

telephones connected directly to the plate P and the filament. I was unable for the particular signals being received on a wave length of 469 meters to make the tube oscillate; hence could get no advantage out of the freak action of this gas-filled tube which would oscillate only at certain narrow bands of frequency.

The other nine tubes of De Forest type were then one after the other put into the circuit shown in Figure 7, and the results may be briefly described as follows:

No. 2 tube: This tube oscillated with just about as much difficulty as did the preceding tube No. 17. It was equally unstable and the oscillations were obtainable only over a very narrow band of frequencies, as in the first case. This tube also was found to contain a considerable amount of gas, since the blue glow was produced with a plate voltage of 18 volts. None of the remaining tubes, numbered respectively 7, 8, 18, 20, 1, 14, 25, and 19, could be forced to oscillate by any combination of changes which could be made in the filament or B battery voltages, or otherwise. All of these were apparently harder tubes than tubes numbered 2 and 17 with which the oscillations were produced for the reason that not less than 40 plate voltage was required to produce the typical blue glow, and in some cases close to 60 volts was required before this condition obtained. It is to be noted that throughout the course of the examination of all these De Forest tubes, including those numbered 2 and 17, which produced oscillations, the filament voltage had to be between 6 and 8 volts instead of $3\frac{1}{2}$ advised by the maker as the upper limit of voltage to be used. These tubes were burned so brightly that their life has been considerably shortened, and from my knowledge of other vacuum tubes no doubt the emission has been greatly reduced by running them at this excess temperature. Such an arrangement for the production of oscillations is too unstable and too costly and too inefficient, even when such oscillations can be obtained.

The experiment of the 13th of March, 1925, using the Diode tube which I described in connection with Mauborgne's sketches, Figure 1, was repeated with this same Diode tube, which it will be remembered was found to be a [fol. 915] hard two-electrode device, but referring to Figure 8, which shows the diagram of connections used in this last test, the addition of a variable condenser C_3 was made to the circuit of Figure 1, so as in every way to duplicate the ar-

range ment described by Mr. Waterman in connection with defendant's Exhibit B, Fleming two-element valve. This variable air condenser C₃ had a maximum value of 0.0016 microfarads. The results of the test of this circuit were similar to those described in connection with Figure 1. As the tube was a hard tube no oscillations could be produced, using a wide range of filament and plate voltage. Also it was again found that the best detection occurs when the plate battery B and the high-frequency choke are entirely removed from the circuit and the telephone receivers connected directly to the plate. In this case, however, the telephone receivers continued to be shunted by the condenser. Starting with zero plate voltage when the circuit arrangement was as shown in Figure 8, and increasing this voltage progressively by steps of two volts, showed a gradual falling off of signal strength from the loudest signals where no voltage was applied to a minimum where the B voltage was 22 volts. To show the effort that was made to obtain oscillations in these circuits, I wish to state that unfortunately I burned out two Diode tubes testing them in the circuit of Figure 8 by applying filament voltages in excess of that stated by the maker as the correct voltage to insure proper operation and expected life of this tube.

To return now to question 17, I wish to state that the two-electrode tube is not inherently capable either of amplifying or operating and, to the best of my knowledge and belief, never has been used in either of these ways in either commercial or governmental communication systems. The literature of the art points out the well-known fact which is known to all radio people, by which I mean not only engineers but operators and others concerned with the care and operation of radio stations, that a two-electrode tube can not be used for anything except straight detection, and by that I mean the rectification which is accomplished by a unilaterally conductive device, such as this two-element tube, or the well-known crystal detector. Nobody that I know of ever proposed to use this tube for amplifying purposes, and as an oscillator, as we glean from the writings of a number of authorities, the hard two-electrode tube simply will not function, whereas a two-electrode tube containing a certain amount of gas, preferably a considerable amount of gas, may be forced by the application of excessive amounts of both filament and plate voltage to cause a change in its characteristic curve, which is normally a rising one,

so that for a time, and with a very critical voltage applied, this tube may have its characteristic changed to a negative one, and thus, exactly like the arc, produce oscillations if the operator is extremely expert and has enough patience and happens to possess a tube in which this change of characteristic can be brought about. Thus there is possible in a few rare freak cases the production of oscillations with a two-electrode gas-filled tube which might suggest that it could be used as an amplifier. No such amplifier action has ever been put into shape for practical use that I know of, nor can I conceive how an audio-frequency amplifier using a couple of these two-electrode gas-filled tubes could be made to successfully operate.

[fol. 916] While the three-electrode tube has been known to be an extremely stable amplifier—that is, a device by which an alternating current of radio or audio frequency applied in the input circuit, namely, the circuit connecting the grid to the filament, produces in the output circuit due to the additional voltage supplied in that circuit locally a much greater degree or amount of power which can be used either to be returned to the grid for the purpose of reinforcing the alternating current supplied to the grid circuit by the antenna or other source, and in this way producing oscillations of very stable character and easily produced over a wide range of frequencies, or the output of the power circuit can be supplied in the case of a radiofrequency device to a detector circuit where another tube or crystal detector can truly rectify the high-frequency oscillations and produce readable signals.

The three-electrode tube then as an amplifier, while having a rising characteristic, produces amplification due to the fact that the energy supplied by the grid needs simply be applied as a potential on the grid, whereas by the assistance of a suitable B battery in the plate circuit, the alternating current, making the grid first positive and then negative, is exactly reproduced as to character and frequency in the plate circuit in an exalted degree due to the application of the proper amount of plate voltage.

To conclude, then, the experiments which I have described simply bear out what the average radio man knows and which has been covered in a number of places in text books and other publications, namely, that there is a distinct difference between a two-electrode tube of the Fleming type, which was a gas-filled tube, and the three-electrode vacuum

tube, whether of the hard or soft type. A further distinction occurs with reference to the two-electrode hard tube which has a rising characteristic only, which can not be changed as can the characteristic of some two-electrode soft tubes. The two-electrode tube is simply a detector or rectifying device, whereas the three-electrode tube can be at once detector and amplifier or oscillator, or a combination of oscillator and detector. It is the one device on which the modern practice of radio is founded.

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Defendant's counsel offers in evidence the following publications and drawings referred to by the witness:

Pages 22 and 23 of the report of the Chief Signal Officer for the year 1901, marked "Defendant's Exhibit I-5."

Pages 46 and 47 of the report of the Chief Signal Officer, for 1902 marked "Defendant's Exhibit J-5."

[fol. 917] Pages 18 to 21, inclusive, of the report of the Chief Signal Officer for 1903, marked "Defendant's Exhibit K-5."

Pages 38 to 41, inclusive, of the report of the Chief Signal Officers for the year 1904, marked "Defendant's Exhibit L-5."

Page 56 of Thermionic Tubes, by John Scott-Taggart, published at London, 1921, marked "Defendant's Exhibit M-5."

Three sheets of Mauborgne's sketches, Figures 1 to 8, inclusive, and the same are marked "Defendant's Exhibit N-5."

Defendant's counsel also offers in evidence the chart "G. W. P. 10A Pickard Chart" forming part of the stipulation entered into, March 13, 1925, covering the stipulated testimony of Doctor Pickard, said sketch being marked "Defendant's Exhibit O-5."

Defendant's counsel also offers in evidence United States patent No. 627650, granted June 27, 1899, to G. Marconi, referred to in the deposition of Loftin, and the same is marked "Defendant's Exhibit P-5."

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18. Question, Referring to the experiment in which you connected up the two-element tube in the circuit of your Figure 6, how did you happen to take this particular circuit, which I understand is the same circuit as shown in the figure on page 56 of the Scott-Taggart book?

Answer. I search the literature of the art through many volumes before I could find that any writer had ever asserted that a two-electrode tube would oscillate, and this circuit referred to is the only case that I could find where anybody ever attempted to illustrate a circuit which purported to produce oscillations using a two-electrode tube. I was simply curious to find out, in spite of my feeling that this circuit would not operate, whether or not the man who patented the device or circuit really had an operable arrangement. My experiment simply confirmed my belief that the circuit would not operate, although I made every effort to have it do so.

19. Question. You have referred to the fact that these two-element tubes acted as detectors. Will you explain the action you referred to when you speak of detector action?

Answer. By detector action I mean that the device called a rectifier, whether it be a two-element tube or a crystal detector, simply rectifies the incoming alternating current by reason of a peculiar curve of the rectifying device itself, from which it can be determined that an incoming modulated signal, let us say, either at the transmitter or at the receiver, is converted by the rectifying device into an audible signal due to the fact that the rectifying device conducts current better in one direction through it than it does in the other. Practically speaking, the action of the detector, due to this unilateral conductivity, is to distort the incoming signal by cutting off the oscillations which would tend to pass through the detector in one particular direction, leaving the other half of the oscillations to actuate the diaphragm of the receiver. This is straight detector action and does not involve amplification in any way.

20. Question. Is there a resonant transfer of energy from the primary or lateral circuit to the secondary or antenna circuit in the quenched-gap type of transmitter, as, for example, the wireless specialty apparatus type, plaintiff's Exhibit No. 87?

Answer. No, there is not a resonant transfer of energy from the lateral circuit of the quenched-spark transmitter to the antenna circuit. This transfer of energy was practically one accomplished by brute force, and not at resonant frequencies, for in this case the energy is transferred from the lateral circuit to the antenna circuit at two frequencies, neither of which corresponds to the wave length emitted by the transmitter. The lateral circuit and the antenna cir-

cuit are not necessarily so adjusted that the time period of oscillation is the same in each of these circuits. In other words, that the product of L and C in each circuit is the same. The object is to transfer the energy from the lateral circuit to the antenna circuit in the shortest possible time and then stop the lateral circuit from oscillating, which is usually accomplished when beats are set up due to the fact that there are present two frequencies differing by a certain amount, hence not resonant. In this type of circuit, as compared with the open-gap type of transmitter of Marconi, it is highly desirable that the lateral circuit shall not persist in oscillating after it has transferred its energy to the antenna circuit at the end of the first beat. In practice we must be able to make such adjustments of the antenna circuit which is the frequency-determining or pace-making circuit upon which depends the frequency of the wave emitted. In this case the lateral circuit must be so coupled to the antenna circuit that it will transfer its energy in the shortest possible time to the antenna circuit, which is quite the opposite effect from that desired when adjusting the open spark gap set of the Marconi type. The word "tuning" is used loosely in connection with the adjustment of the circuits of a quenched-spark transmitter so that the apparatus may emit one single persistent wave. It does not mean the adjustment of one circuit to the same time period of oscillation as another in this regard, but it means the making of all adjustments including the adjustment of the values of L and C in the lateral circuit as well as in the antenna circuit, and the adjustment of the coupling to so tight a degree that the energy is transferred to the antenna circuit at two frequencies not the same as each other but differing by such an amount that beats between the two frequencies set up will assist in the operation of quenching out or preventing the further supply of energy from the lateral circuit to the antenna at the end of the first beat so that the energy may be radiated from the antenna at the predetermined frequency which is not the frequency of either of the two high-frequency oscillations by means of which the energy is transferred from the lateral circuit to the antenna.

21. Question. Is there a resonant transfer of energy from the primary or lateral circuit to the secondary or antenna circuit in the Marconi open gap loosely coupled transmitter,

as, for example, the right-hand figure in plaintiff's Exhibit No. 99, Marconi 763772?

Answer. Yes. With this arrangement it is essential, first, that the lateral circuit have its time period of oscillation accurately adjusted to the time period of oscillation of the [fol. 919] antenna circuit in order that efficient radiation may take place in this type of transmitter. Secondly, the coupling must be the least possible so that there may not be produced two frequencies in both circuits—lateral and antenna—neither of which frequencies is in resonance with or the same as the resonant frequency to which the lateral circuit and the antenna circuit are first adjusted. Third, it is necessary that the lateral circuit with its open-spark gap be of such character and arrangement that the oscillations in it will persist as long as possible, so that the energy may be fed from that circuit to the antenna circuit as slowly as possible in order that through resonance, or the resonant transfer of energy, the effects produced in the antenna shall be radiated at but a single frequency and with as much power as possible. If resonance between these two circuits did not exist, in other words, if the energy was transferred at two different frequencies, it would *bever* be radiated at but a single frequency from the antenna. Mr. Marconi has carefully arranged his circuits for the accurate tuning of each providing for the resonant transfer of energy from one circuit to the other with the minimum coupling.

(Direct examination closed.)

Cross-examination.

By Mr. Vaill:

22. Cross-question. Major Mauborgne, you have been continuously in commission as an officer in the United States Army since your appointment in 1903?

Answer. I have.

23. Cross-question. Have you ever during your connection with the United States Army been retained by any electrical manufacturing concern as an electrical consulting engineer, or have you ever acted as such for any manufacturing concerns?

Answer. No, sir, not for any manufacturing concerns.

24. Cross-question. Have you ever acted for or been retained by any wireless telegraph company as a consulting engineer?

Answer. No, sir.

25. Cross-question. Referring to the year 1906 when you stated that your regiment was moved to Zamboanga, Mindanao, what concern erected the radio station which you mentioned in that connection?

Answer. To the best of my knowledge and belief, the radio station was installed by the Signal Corps itself, and not by any company.

26. Cross-question. You stated you observed the erection of this station. Was the work actually done by Army men or by outside employees?

Answer. As I recollect it, there were some civilian employees of the Signal Corps—I don't know their ratings—perhaps one of them at least may have been called an assistant at large, Signal Corps, but I did see several enlisted men assisting in the work of wiring the station and installing the apparatus, which I later saw in completed working condition.

27. Cross-question. Did you examine the apparatus in detail?

Answer. Enough to be able to say generally what the character of it was, but not making in any sense a wiring diagram of the connection.

28. Cross-question. Did you ascertain from your examination of this apparatus by whom it was manufactured?

[fol. 920] Answer. I did not examine each piece of apparatus to see which company made each piece of apparatus. A document which I have put in evidence, namely, defendant's Exhibit H-5, contains the wrapper only of the document numbered 152677, which letter I have recently perused. The letter itself unfortunately was not put in evidence. This letter contained certain appendices showing that the Chief Signal Officer of the Army directed the chief signal officer of the Department of California to have certain parts of the apparatus, such as the loading coils for the transmitter, manufactured under Captain Wildman's direction and according to his design, somewhere in the vicinity of San Francisco. This letter also stated just where each article, such as keys and spark gaps, would be obtained. It also stated that De Forest receivers would be shipped. A picture of such a receiver installed at Jolo was referred to in connection with my description of defendant's Exhibit H-5.

29. Cross-question. Do you know whether this apparatus referred to in your last answer was a coupled set arranged according to a patent which I understand has been granted to Wildman for transmitting apparatus for wireless telegraphy?

Answer. Captain Wildman in June, 1904, was granted a patent on a direct connected or autotransformer arrangement for coupling the lateral circuit to the antenna. The photograph just shown as pertaining to Jolo shows this helix, and to the best of my recollection this helix was arranged with four connections to it, used for coupling the lateral circuit to the antenna circuit with the addition of what was called an anchor gap.

30. Cross-question. Although you have stated as to the source of some of the apparatus at Jolo, I believe you have not answered my question as to the source of the apparatus at Zamboanga. Will you state the answer to that question?

Answer. I did not put it clearly that the apparatus for both stations, Zamboanga and Jolo, was bought at exactly the same time and that the apparatus for both stations was identical.

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32. Cross-question. What were your special duties while stationed at Zamboanga?

Answer. I was on duty as an officer of a company of the Sixth Infantry, and for a while acting as post signal officer. This radio station, however, was not under my control, but directly under the control of the signal officer of the Department of Mindanao, stationed in the same post of Zamboanga.

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[fols. 921-922] 38. Cross-Question. During and up to the year 1914 to what extent were you familiar with the number and location of fixed transmitting land stations operated by the War Department and under the supervision of the Signal Corps?

Answer. Due to my practical work in operating radio apparatus in a number of stations of the Signal Corps, and from my contact with publications of the various governmental departments including the Department of Commerce, I can say that I had a good general idea of the

location of the fixed stations which were operated by the Signal Corps within the period 1904 to 1914.

39. Cross-question. Will you please state specifically the name and location of fixed land transmitting stations, operated by the United States Army and under the supervision of the Signal Corps which you had inspected or operated personally up to and including the year 1914?

Answer. Fort Leavenworth, Kans.; Fort Riley, Kans.; Fort Omaha, Nebr.; Fort Mills, Corregidor, Philippine Islands. As far as I can recollect, these are the only fixed stations of the Signal Corps which I actually inspected and operated up to the year 1914.

40. Cross-question. Of the stations you have just mentioned, which ones did you actually personally operate yourself?

Answer. I have just testified that I operated all of the stations mentioned, and by that I mean personally.

[fol. 923] 52. Cross-question. Referring to plaintiff's Exhibit 87, Wireless Specialty Apparatus Type, will you please state when and where if at all you personally operated a transmitting station having the connections shown at the left hand side of this exhibit?

Answer. I have operated at Fort Leavenworth, Kans. a pack set having somewhat the same arrangement as that shown in the exhibit mentioned, although the inductances or loading coils in the case of the apparatus which I actually operated were not inductively connected but the linking between the closed oscillating circuit shown in red in the drawing was accomplished by means of an auto-transformer shown in Photograph 5449, which forms part of defendant's Exhibit H-5 which is the 500 cycle quenched gap field set of November, 1912. Also in the year 1917 I operated at Fort Leavenworth, Kans. the inductively coupled quenched spark type of pack set shown in Photograph 6202 forming part of defendant's Exhibit H-5. This latter set had two coils or spiral inductances which formed a variometer or arrangement for tuning or adjusting the time period of oscillation or the closed or lateral circuit corresponding to the circuit shown in red in plaintiff's Exhibit 87. In this case a separate loading coil or inductance was inserted in the antenna circuit for receiving the energy transferred from the lateral circuit corresponding to the

coil d' shown in plaintiff's Exhibit 87. This is a slightly different organization from that shown in plaintiff's Exhibit 87 inasmuch as no loading inductance g was placed in the antenna circuit and additional means for varying the inductance of the lateral circuit had been provided.

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53. Cross-question. Will you please state whether or not you have personally operated a transmitting set having the same connections and apparatus indicated in the left-hand portion of plaintiff's Exhibit 87?

Answer. I have not operated a set of the Wireless Specialty Apparatus type with the connections shown in plaintiff's Exhibit 87, but anyone skilled in the art will recognize the fact that the inductance d shown in plaintiff's Exhibit 87, being a variable inductance simply is no different in function from an inductance variable not only by changing turns but also by the action of changing inductance in that circuit brought about by varying the coupling between the two coils which form the variometer. In other words a variometer is nothing but a variable inductance and can readily be substituted in the red circuit, plaintiff's Exhibit 87, instead of the variable inductance d shown in the circuit in red. The fact that the 1915 pack set had no loading coil separated as indicated in the diagram in plaintiff's Exhibit 87, at the point g from the inductance spiral which provided the method of tuning the antenna and the means for coupling the antenna circuit to the lateral circuit, presents no functional difference over the organization shown in plaintiff's Exhibit 87 in the antenna circuit of the transmitting station, as anyone versed in the radio art will testify. Hence my knowledge of the tuning of a transmitting station such as that shown in the left-hand figure of plaintiff's Exhibit 87 can not be questioned because to the lay observer there appears to be a difference which does not in fact exist, between the transmitting station connections shown in plaintiff's Exhibit 87 and the circuit arrangements which existed in the 1915 Signal Corps pack set, illustrated in Photograph 6202, forming part of defendant's Exhibit H-5.

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[fol. 925] 60. Cross-question. In a previous answer on direct examination you mention a Major Russell. Is he the same gentleman who was chief signal officer of the American Expeditionary Forces in the World War?

Answer. Yes, sir.

61. Cross-question. Is he generally considered a capable and efficient officer as to his conduct of affairs relating to radio signalling?

[fol. 926] Answer. General Russell has left the service, and up to the year 1915 or 1916 could be said to be one of the most efficient officers of the Signal Corps so far as a knowledge of radio communication systems and apparatus was concerned, but the General himself, while I was traveling with him in France in the early part of 1919, stated that he had lost all direct contact with the intimate details of the radio art which had been born with the advent of the modern vacuum tube transmitter and receiver. He stated that in his position as an executive officer he had had no time to keep up with the advance and progress of the radio art, although his efficiency along other lines undoubtedly was as high, if not higher than that which he had ever attained before.

62. Cross-question. Was Major Russell the commanding officer at Fort Leavenworth when you were stationed there in 1909 or 1910?

Answer. No, sir. He was the commandant and assistant director of the Army Signal School at Fort Leavenworth, Kans., at that time.

63. Cross-question. Do you know Prof. G. W. Pierce?

Answer. I am not personally acquainted with the gentleman, although I have read many of his contributions to the literature of the art and at one time was in communication with him as a result of his noticing an article of mine concerning the action of coupled circuits which he had seen in the London Electrician and about which he made some comments in writing to me, inclosing a mathematical treatise of his own on the same subject.

64. Cross-question. In answer to the first question on direct examination you state that you prepared for the Signal Corps a small volume on the uses of the wave meter in wireless telegraphy which you published in 1913. You sent this book, or the manuscript or draft of it, before publication to Professor Pierce for criticisms and suggestions, did you not?

Answer. No, sir; I did not. The McGraw-Hill Co., who later published the volume, before deciding whether or not to publish this volume, submitted the manuscript to

Professor Pierce for consideration in order to determine whether or not they should publish it.

65. Cross-question. I presume that you will admit that this was because of the high regard that the McGraw-Hill Co. had for Professor Pierce's wide knowledge and experience in radio matters?

Answer. I believe so.

66. Cross-question. Are you a member of the Institute of Radio Engineers?

Answer. Yes, sir; I hold a membership in that society.

67. Cross-question. What are the objects and functions of the Institute of Radio Engineers, according to your understanding?

Answer. I suppose the principal object of this organization is to promote the general interest in radio engineering and to afford a means for promoting discussions among its members concerning live radio topics with a view to the further advancement of the art. Its proceedings, which it publishes, form one of the principal sources of up-to-date knowledge concerning radio engineering principles.

68. Cross-question. It is generally understood, is it not, that the publications of the Institute of Radio Engineers [vol. 927] are accurate statements of matters relating to the distribution of the advanced knowledge of radio principles?

Answer. No, sir; it is not so understood. In fact, I think you will find that in every volume of these proceedings the editor states that the papers presented therein represent the individual views of the writers of the paper, and that the institute simply reproduces these papers usually after a discussion by other members of the institute, which discussion in many cases brings out a marked difference of opinion between the various members in discussing the paper as to the accuracy or correctness of the principles enunciated by the writers of the paper without in any way putting its official stamp of approval on the papers published as representing an accurate statement of facts or that the views of the writer are, in the opinion of the institute as a body, to be taken as gospel truth. These are not the exact words employed, but is about the substance of what the editor has to say.

69. Cross-question. The same is true, is it not, of practically all of the publications of other well known engineering associations of high standing in this country?

Answer. Yes; with the exception that where the principles announced have been accepted by the majority of radio engineers and scientists as agreeing with their judgment based on their own individual experiences, such principles gradually find their way into the text books which form the basis of the teaching of the principles of the art, and which may or may not be disproved at a later date as having been incorrect in the light of more recent developments and knowledge of the art obtained.

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70. Cross-question. Are you a member of the American Institute of Electrical Engineers?

Answer. No, sir.

71. Cross-question. What is your understanding of the value of the publications of the American Institute of Electrical Engineers as regards the distribution of advanced knowledge of electrical subjects?

Answer. My comments concerning the publications of the Institute of Radio Engineers are equally applicable to those of the American Institute of Electrical Engineers. These publications enrich the knowledge of the profession, concerning recent developments, but no paper appearing therein, unless it be the official report of standardization proceedings, or the report of some official decision of the institute itself, can be taken as anything more than the individual expression of opinion on the part of the writer of the paper. In some cases the doctrines expressed in this manner by individuals are determined to be correct only after litigation, as is well known.

72. Cross-question. According to your experience what has been the maximum distance attained by a transmitter of the closed or loop circuit type?

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[fol. 928] 73. Cross-question. In answer to question 6 on direct examination you mentioned the reception of radiotelephony. Will you please state from your knowledge of Signal Corps matters when radiotelephony first began to be used as a regular means of communication in the Army?

Answer. Radiotelephone sets for the use of the Army, particularly with aircraft, and from aircraft to ground, were designed in 1917 and some were tested, either during the last few months of that year or in the early part of 1918.

74. Cross-question. Have you ever used or witnessed the use of a two-element vacuum tube in the reception of spoken words by radiotelephony?

Answer. I have, as I described in connection with the tests which I made of both the Diode two-electrode tube and an early De Forest amplifier tube which had its grid and plate directly connected together so as to form but one element.

75. Cross-question. Is that the first instance of your having witnessed such a use of the two-element tube?

Answer. Yes, sir; although, as I state in my testimony, the Diode tube to the best of my knowledge was put on the market about a year ago for the purpose of providing radio broadcast listeners with a detecting device which the manufacturer sold with the view to replacing the crystal detector.

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[fol. 929] 80. Cross-question. During your experiments referred to in answer to cross-question 17 on direct examination, will you please state who was present at the time you made these tests or experiments?

Answer. A civilian, an employee of the Air Service, named Mr. Richardson, who is located at the Bureau of Standards, was present.

81. Cross-question. To what extent did you confer with Commander Loftin concerning these experiments before conducting?

Answer. I had no conference of any sort with Commander Loftin about conducting any such tests before I actually performed the experiments. I performed these experiments principally for my own satisfaction and showed the results which I obtained to the counsel for the defendant and Mr. Loftin after the first experiments were performed.

82. Cross-question. What did you mean by the use of the word "principally" in the last answer?

Answer. I wanted to have some first hand knowledge of how hard and soft two-electrode tubes would act; that is, as the opportunity actually presented itself for me to get hold of a modern two electrode tube, I wished to see how they bore out the theories concerning the action of these tubes which I had found in the works of Van der Bijl and other writers.

83. Cross-question. Did you conduct these experiments before or after you were requested to testify in this case?

Answer. After.

84. Cross-question. To what extent were you advised as to what you were to testify about?

Answer. Are you referring to this matter of vacuum tubes?

85. Cross-question. Yes?

Answer. I was advised to state exactly what happened in the tests, and as you noticed I brought here my original notes which I practically reproduced in the record, with but very little addition.

86. Cross-question. To what extent did you read over the testimony given by Commander Loftin in this case prior to testifying?

Answer. I think I read not over one-third of the Loftin record, and that was the first third.

87. Cross-question. Did you read over the portion of Commander Loftin's testimony wherein he testified concerning vacuum tubes?

Answer. I did not.

88. Cross-question. In answer to question 20 on direct examination you stated "Referring to the quenched gap type of transmitter as for example the Wireless Specialty Apparatus type, plaintiff's Exhibit No. 87, that "The lateral circuit and the antenna circuit are not necessarily so adjusted that the time period of oscillation is the same in each of these circuits." It is a fact, is it not, that in the usual practical operation of such circuits the antenna circuit and the lateral circuit are so adjusted that their periods are in the vicinity of each other?

Answer. That is the idea exactly, that they are in the vicinity of each other and not as in the case of the ordinary [fol. 930] coupled circuit transmitter of the open spark gap type, exactly on the same frequency to which it is highly essential as I have testified, that this Marconi transmitter be tuned in order that there may take place a transfer of energy at the resonant frequency from the lateral circuit to the antenna circuit.

89. Cross-question. Assuming that the primary and antenna circuit of a quenched spark transmitter had not been previously calibrated, and that you set the primary, or what I think you have called the lateral circuit, at some wave length within the range of the set, but which wave

length is at the time unknown to you, could you correctly adjust the transmitter so that the unknown wave length would be emitted with maximum radiation?

Answer. Yes, sir.

90. Cross-question. Will you describe briefly how you would accomplish this?

Answer. Perhaps I shall have to qualify my statement "Yes, sir," slightly, by answering that I could tune it to an unknown wave length which would probably not be the wave length to which the lateral circuit had been tuned, or at which it was accidentally set before the operation starts. In this case we must proceed from the adjustment of the primary to the adjustment of the antenna circuit in order that there may be emitted from the transmitter a good clear note with the maximum radiation in the antenna ammeter. This involves then, briefly, the placing of the antenna inductance in fairly close coupling relation to the lateral circuit, and by actuating this circuit with such close coupling to so adjust the antenna inductance, that there will be produced in the antenna circuit a maximum amount of energy and when the note as listened to will be a clear one when the energy in the antenna, as indicated by the ammeter is greatest with the generator running at the proper frequency so that this note may be produced. The coupling must then be varied as well as the inductance in the antenna circuit, since this degree of coupling is highly critical if we are not to produce a ragged note and a double humped wave from the transmitter due to the extremely close coupling between the lateral circuit and the antenna circuit which we must employ if the quenching of the lateral circuit gap is to be accomplished. Had the lateral circuit been examined with a wave meter prior to this operation and its wave length determined, and then later had the wave meter been properly placed so as to measure the wave emitted by the antenna circuit when a single humped resonance curve was obtained, or in other words, a single frequency or wave length emitted from the antenna, it would probably be found that the wave length of the antenna indicated by the wave meter in this latter case was slightly different from that which we obtained as the wave length of the lateral circuit due to the fact that close coupling has been resorted to, and that in order to produce beats there must be set up two frequencies differing by such an amount that the beats can take place.

If the coupling is not right these two different frequencies will appear in the antenna circuit as measured by the wave meter and we will know that the gap is not being properly quenched. That is why I stated that there was not a resonant transfer of energy from the primary or lateral circuit to the antenna circuit in my direct examination.

[fol. 931] Now, in connection with your question I note that you have not started out with the same premise with which I started when I described how to tune a quenched spark transmitter, namely, that there must be emitted from the transmitter a wave of predetermined desired length which requires that the lateral circuit be adjusted as to its values of L and C and the coupling be so arranged that when the tuning operation involving all these adjustments is completed, the antenna shall emit not an unknown or undesired frequency, but one which is predetermined.

91. Cross-question. In adjusting a circuit, starting with an unknown wave length, as stated in my last question, how would you know or determine the relation of the product of L and C of the primary to the product of L and C of the secondary or antenna circuit when adjusting for maximum radiation?

Answer. In adjusting for an unknown wave length it is not necessary to determine in either case the product of L and C in the lateral circuit and in the antenna circuit if the operation of tuning is carried on as I have just described, because in this case we are not trying to make the product of L and C in the lateral circuit exactly equal to that of the antenna circuit, but rather we are trying for correct adjustment which will result, as I have stated, in the values of L and C of one circuit, being slightly different from the values of L and C of the other circuit, perhaps it is true by only a small amount, when we get the maximum radiation with a pure note and good quenching. Now, if you ask me how I determine the difference between these two frequencies which result from the product of L and C in the lateral circuit and the product of L and C in the antenna circuit, the lateral circuit in the first case can be measured with a wave meter, its wave length determined, and the values of L and C , or rather the product of these values, determined by substituting the wave length found in the formula, the wave length equals 1.885 times the square root of LC . Similarly with the antenna coupled to the lateral circuit, however, the emitted wave is measured with

a wave meter, and by the same process, and using the same formula, the product of the L and the C of that circuit can be determined and this latter value with reference to the value found for the product of LC in the lateral circuit can be compared, but it is not seen that this process is at all necessary in order that the station may be adjusted to transmit a single frequency on a properly quenched transmitter.

92. Cross-question. It is true, is it not, that in tuning correctly to an unknown wave length the procedure in the act of tuning is carried out without a knowledge that the LC products in the primary and secondary circuits are the same or different?

Answer. That is true up to the point where we finally secure the maximum radiation with a pure note, and then, even if we have no wave meter, we are justified in saying that the station has its lateral circuit and its antenna circuit so adjusted that the product of L and C in the lateral circuit is very near the same as the product of the L and C in the antenna.

Redirect examination.

By Mr. Edwards:

93. Redirect question. Are you willing to repeat in the presence of counsel for the plaintiff and plaintiff's experts, the tests referred to in your direct examination?

[fol. 932] Answer. Yes, sir; whenever desired.

(Defendant's counsel offers to arrange for a repetition of the tests referred to if so requested by plaintiff's counsel.)

(The examination by counsel being concluded, the witness, in compliance with the rule of the court requiring him to state whether he knows of any other matter relative to the claim in question, and if he does to state it, says he does not.)

Deposition of Robert H. Marriott, for defendants, taken at Seattle, Wash., on the 26th day of March, A. D. 1925

Claimant's counsel, Edward W. Vaill, Esq.; defendant's counsel, Clifton V. Edwards, Esq.

ROBERT H. MARRIOTT, having been produced as a witness on behalf of the defendant, was by me sworn, before any

question was put to him, to tell the truth, the whole truth, and nothing but the truth, relative to the said question, and thereupon deposed and said that his name is Robert H. Marriott; that his occupation is radio engineer; that he is 46 years of age; that his residence is Bremerton, Wash.; that he has no interest, direct or indirect, in the claim in controversy; and that he is not related to the plaintiff; and thereupon the said Robert H. Marriott was examined by counsel for the defendant and, in answer to interrogatories, testified as follows:

Direct examination.

By Mr. Edwards:

1. Question. Where are you employed, Mr. Marriott, and what are your duties?

Answer. I am employed at the Puget Sound Navy Yard. My duty is to act as chief radio engineer for the naval radio activities at Puget Sound Navy Yard for the handling of naval vessels in the thirteenth naval district for the handling of naval shore stations.

2. Question. Please state what experience you have had in the use of radio apparatus and in keeping in touch with the developments in the radio art.

Answer. I became interested in wireless or radio some time previous to 1897 while in high school. I took up the subject theoretically and by experiment at Ohio State University from 1897 to 1901 in connection with general science course for degree of bachelor of science. In June, 1901, I obtained employment with the American Wireless Telephone & Telegraph Co. and took part in the building of radio stations in New Jersey. In the fall of 1901 I became chief engineer of the Pacific & Continental Wireless Telephone & Telegraph Co. and went to Denver, Colo., where I built transmitters and receivers. In April, 1902, I took those transmitters and receivers to southern California and constructed a radio station at Avalon, on Catalina Island, and another near San Pedro, on the mainland, and put these stations under operation. In the fall of 1902 I went east for the companies to prosecute some patent applications and get in touch with what was being done with radio in the East. While in Annapolis, Md., I examined the apparatus that the Navy had at Annapolis. That apparatus included transmitters and receivers of German and

[fol. 933] French manufacture. Later in 1902 I went to Denver, Colo., and went to work for the Carstarphan Electric Co., where I carried on experimental wireless work, manufactured X-ray apparatus, did some work for the De Forest Wireless Telegraph Co., and some wireless telephone work for the Ashley Wireless Co. This covered a period up to the 1905. In 1905 I went to work for the American De Forest Wireless Telegraph Co. and constructed stations in Wyoming and Colorado, and acted as advisory engineer and inspector for the construction of stations in Texas and stations on some vessels entering Galveston. This covered a period up to 1907. In 1907 I went to the Pacific coast for the same company and made arrangements for the construction of stations at Seattle, Portland, Astoria, and elsewhere, directly supervising the construction of the station at Astoria and the station at Portland. In the fall of 1907 I returned to Colorado and dismantled the Colorado and Wyoming stations and went to New York. The De Forest Co., in the meantime, had been absorbed by the United Wireless Telegraph Co. At New York I carried on experimental work, and examined inventions for the United Wireless Telegraph Co. In 1909 I changed to construction and maintenance work, having to do with the construction and maintenance of stations, chiefly between Eastport, Me., and Cape Hattery, and those stations located on vessels entering that district. In 1911 I went with the American Marconi Co., acting as assistant chief engineer for a time and being in charge of the experimental apparatus part. In 1912 I became United States radio inspector, coming under the Department of Commerce and with headquarters at New York. In 1915 I changed from the Department of Commerce to the Navy Department, to carry on the work which I am now carrying on.

3. Question. In the development of wireless telegraphy and telephony in the United States since 1900, what have been, to your knowledge, the principal causes of the increases in distances of transmission and selectivity?

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Answer. Using my paper entitled "United States radio development," in the Proceedings of the Institute of Radio Engineers, June, 1917, Volume V, No. 3, as a guide to refresh my memory, the causes of increase in distances and selectivity are the changes made in detectors, receiving ap-

paratus, and transmitters. For example, in 1899, coherers were used. These devices were erratic and unreliable. Also they were easily rendered insensitive and were comparatively expensive. About 1901 an improvement was made when the combination of a telephone receiver and detector was brought into use. These detectors were often more sensitive than the coherer, and were inexpensive and easy to adjust or replace. Also by the telephone method of reception the operator was able to differentiate between the static and signals. For example, in 1901 I used an inexpensive detector which consisted of a contact between a polished steel point and oxidized iron. Along about that time, or a little later, two or three forms of electrolytic detectors came into use. Some of these were extremely sensitive. But the acid used in them was harmful and the [fol. 934] more sensitive ones were often injured by static. A little later the more durable and more easily adjusted crystal detectors came into use, and are still in use. In 1906 the three electrode vacuum tube detector came into use. It was a great improvement as a detector and later came into use as an amplifier, as a relay, and as a radio transmitter, and changed the entire status of radio telegraphy and telephony, including matters pertaining to distance and selectivity. In radio transmitters, the first transmitters used in about 1899 in this country consisted of an induction coil with a spark gap, one end of which was connected to the ground and the other end of which was connected to an insulated antenna. That transmitter was called the plain antenna type of transmitter. The induction coil used with it produced very low spark frequencies, and the voltage being applied directly to the antenna, caused the insulators to break down and the combination produced very short highly damped wave trains, all of which tended to limit distances and selectivity. In about 1903 tuned coupled circuit transmitters came into noticeable use in this country as compared with plain antennae transmitters. In these tuned coupled circuit transmitters the spark gap was connected at one end to an inductance coil and at one end to a condenser, the condenser and inductance coil being connected in a series. Another inductance coil in inductive relation to the inductance coil in the spark gap circuit was connected at one end to an antenna and at the other end to earth. The spark gap circuit and the antenna circuit were tuned to the same frequency. With this arrangement a

greater amount of power could be used without breaking down antenna insulators, and longer wave trains were obtained, which improved selectivity. Also in this country further improvement was made by using alternating current transformers in place of induction coils, producing higher spark frequency, which helped particularly in increase of range and distance. About 1909 impulse excitation transmitters came into use in this country. These transmitters consisted of a spark gap made up of a number of short gaps in series. One end of this gap was connected to an inductance, the other end to a capacity, the inductance and capacity being connected in series. Tightly coupled to this inductance was another inductance, one end of which was connected to the ground and the other end of which was connected to the antenna. The antenna circuit was adjusted to a given wave length and the spark gap circuit was adjusted to give maximum current in the antenna circuit. This impulse excitation produced longer wave trains with nearly all the energy radiated in one wave length, thereby improving selectivity and distance. In about 1912 constant amplitude transmitters came into noticeable use in this country. In this case the spark gap consisted of a direct current arc, one end of which was connected to earth, and the other end of which was connected through an inductance to the antenna. This produced a greater part of its energy in one wave length, and the waves were of constant amplitude and not successive trains of diminishing waves, as had been used heretofore. This again increased selectivity and distance. About 1915 the three-electrode vacuum tube came into prominent use as a constant amplitude transmitter, when it was used by the Bell Telephone interests in transmitting speech from Radio, Va., to Mare Island, Calif., Honolulu, and Paris. It was better adapted for use at all [fol. 935] radio frequencies and for use as a radio telephone than the arc was. It therefore served as an improvement for distances and selectivity as well as other features, and is the device now used for radio broadcasting and is taking the place of radiotelegraph arc and spark transmitters. Among the constant amplitude transmitters there were several high-frequency dynamos, such as the Goldschmidt dynamo used at Tuckerton, N. J., for transmitting across the Atlantic to Germany in 1913, and the Fessenden dynamo as used by Fessenden some years previous to 1913, and which was developed by Alexanderson, and is now in use

for trans-Atlantic communication. These dynamos were good for distance and selectivity, but they were limited as to the number of different wave lengths they could produce. Also they had to be very carefully constructed and cared for.

4. Question. Were the so-called impulse excitation transmitters, to which you have referred, known by any other name?

Answer. Yes; they were frequently called quenched gap transmitters.

5. Question. What can you say as to the relative importance, as manifested by increase in range, sensitivity, or extent of use, of the various improvements set out in your answer to question 3?

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Answer. In the time of the coherer and plain antenna transmitters the ranges were usually very short. It was often difficult to telegraph 10 miles, and 25 miles was fairly good working. With the use of the detector and telephone method reception, commercially reliable communication was obtained between the Catalina Islands and the mainland of California in 1902. The use of the detector method of reception with telephones and the use of the tuned coupled circuit made it possible to give fairly reliable service over a distance of about 200 miles in 1905; and in the winter of 1905 it was possible to hear ships on the Atlantic, although I was located in Denver, Colo. Using the impulse excitation transmitters and similar detector receivers and telephones, the reliable commercial distance was increased, to the best of my recollection, about fifty or a hundred per cent. Using the constant amplitude transmitters, the range was so increased that it was possible to span the Atlantic Ocean commercially, and as a test it has been possible since 1915 to read European stations in Bremerton, Wash. Part of the ability to read constant amplitude stations over this extreme distance was due to the use of the three-electrode vacuum tube as an oscillating detector and amplifier. However, the Atlantic was spanned commercially, using other forms of detectors, as was also the case between Honolulu and San Francisco. With the coming of the tuned coupled circuit transmitter, the plain antenna transmitter began to go out of use. They came back into use again temporarily in 1912 as an auxiliary, but were replaced by tuned coupled transmitters and other transmitters later. With the coming of the impulse excitation transmitters, they first began

to be installed instead of tuned coupled circuit transmitters, and later they more and more replaced the tuned coupled circuit transmitters until the tuned coupled circuit transmitters have nearly gone out of existence. The impulse [fol. 936] excitation transmitters likewise have given place in recent years to constant amplitude transmitters. The sensitivity of modern three-electrode vacuum tube apparatus is such that operators now require a signal about ten times as strong as they required when crystal detectors were used; that is, they are used to so much louder signals with the three-electrode tube arrangements and the three-electrode tube arrangements are so much more sensitive.

6. Question. From your experience what can you say as to the relative efficiency and extent of use of the so-called tuned coupled circuit transmitter, as compared with that of the impulse excitation transmitter?

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Answer. As I recall my experience as a radio inspector in New York, an impulse excitation transmitter, using about the same amount of power input, produced about twice as much current in the antenna as that produced by a tuned coupled circuit transmitter. As I recall my experience with the Marconi Co., we started in 1911 to deliver an impulse excitation transmitters instead of tuned coupled circuit transmitters, and to substitute them for tuned coupled circuit transmitters. While inspector in New York, the United Fruit Co. changed from tuned coupled circuit transmitters to impulse excitation transmitters, and the Navy changed from tuned coupled circuit transmitters to impulse excitation transmitters.

7. Question. You stated that the plain antenna transmitter came back into use again temporarily in 1912. Will you explain what caused this temporary use?

Answer. The law of the United States which went into effect in 1912 required that vessels of certain classes be equipped with radio, and so equipped that a radio transmitter could be operated for four hours without getting its power from the engine-room. In order to operate the regular radio transmitter, it would have been necessary to equip the vessel with a large storage battery or something equally expensive. Therefore the Marconi Co. brought back its cheap induction coil type, plain antenna transmitter, which could be operated from a comparatively small storage battery.

8. Question. So far as you know, are the tuned coupled circuit transmitters now in use for commercial or governmental work?

Answer. No.

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[fol. 937] 11. Question. Referring back to your answer to question 6, will you state what type of transmitter the Marconi Co. was employing before starting to deliver impulse excitation transmitters in or about 1911?

Answer. At that time the American Marconi Co. had taken over the United Wireless and its transmitters were chiefly the ex-United Wireless transmitters, which were tuned coupled circuit transmitters.

12. Question. And when you say that "We started in 1911 to deliver impulse excitation transmitters," do you mean that the American Marconi Co. started to deliver them?

Answer. I mean that the American Marconi Co. started to manufacture them in the latter part of 1911 and began deliveries of them around December, 1911, or January, 1912.

13. Question. And thereafter, except for the temporary use of the plain antenna transmitter in or about 1912, did the American Marconi Co. manufacture and use the impulse excitation type of transmitters and abandon the tuned coupled circuit transmitter?

Answer. Yes.

14. Question. In order that we may have no misunderstanding as to what is meant by the plain antenna transmitter, the tuned coupled circuit transmitter, and the impulse excitation transmitter, can you make a sketch or diagram illustrating each of these types?

Answer. I have made such a sketch.

The sketch made by the witness Figures 1, 2, and 3, is offered in evidence and marked "Defendant's Exhibit Q-5," Marriott sketch.

15. Question. Referring to Figures 2 and 3 of your sketch, Exhibit Q-5, what, if any, differences are intended to be indicated in the representations of the spark gap and the coupling coils LL-1 of the respective figures?

Answer. The spark gap in Figure 2 consists of the gap between the ends of two metal rods, the gap being about half an inch in length and in free air. The gap in Figure 3 [fol. 938] consists of a number of short gaps in series. The faces of these short gaps are broad and backed by considerable metal designed to carry away heat rapidly. The short gap is inclosed in such a manner that it is air tight. The short gap length between sparking faces is about one-hundredth of 1 inch. The entire gap comprises a number of these short gaps in series. All of the inductance L in Figure 3 is closer to all of the inductance L^1 than it is in Figure 2.

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17. Question. In your direct examination you have made reference to a paper entitled "United States radio development" written by yourself, and appearing in the Proceedings of the Institute of Radio Engineers in June, 1917. Please state what this paper purports to set forth and the basis for the facts therein stated.

Answer. The paper was intended to set forth all the important elements bringing about the evolution of radio in the United States up to 1915, and the statements are made from my experience in contact with radio and from the written records of the United States Government.

18. Question. Will you state how you came to prepare this paper, and give us some idea of the time required and sources availed of in the preparation of the paper?

Answer. In 1915 there was a World's Fair at San Francisco, in connection with which a Panama-Pacific Convention of Engineers was held, and the paper was desired for a joint meeting of the Institute of Radio Engineers and the American Institute of Electrical Engineers, and I supplied this paper entitled "United States radio development" and read it at that joint meeting. My own personal notes, from which this paper was taken, extended back to 1897. The time used in searching the Government records was from the latter part of February, 1915, to about July, 1915, most of the records being delivered to me at Brooklyn Navy Yard, New York, by order of some person in authority. I think it was the Attorney General.

19. Question. To the best of your knowledge, information, and belief, are the facts stated in that article and represented in the two charts accompanying the article, true?

Answer. Yes.

(The article referred to by the witness is offered in evidence by defendant's counsel. The article comprises pages 179 to 197, inclusive, of the Proceedings of the Institute of Radio Engineers for June, 1917, and is marked "Defendant's Exhibit R-5.")

[fol. 939] 20. Question. What, if any, experience have you had with two-element vacuum tubes?

Answer. I tried them as detectors on two or three occasions previous to 1911, and in 1911 and 1912 I had charge of what was called the Experimental Apparatus Department of the American Marconi Wireless Telegraph Co., in connection with their shop or factory at Cliff and Fulton Streets, New York, where one room was given over to the sale of radio apparatus. The Fleming valves, or two-element vacuum tubes, were advertised and sold from this point. I tested all of the valves that were sold in that manner and some of those that went through the shop in connection with other Marconi enterprises. The tests were usually made in laboratory fashion by using a buzzer for a transmitter; however, on some occasions I tested them by using an outside antenna and receiving from some radio station.

21. Question. To what extent were these two-element tubes sold by the Marconi Co.?

Answer. I can not recall exactly how many of those tubes were sold through me, but I believe it was about 100. There were possibly a few sold through others.

22. Question. Have you any idea as to how many may have been sold through others?

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Answer. As nearly as I can remember now, I believe I sold a majority of all that were sold. There may have been some arrangement between the American Marconi Co. and other Marconi companies whereby sales were made to these other Marconi companies of which I have no definite recollection at present.

23. Question. For what purpose were these two element tubes sold by the Marconi Co.?

Answer. The ones I sold were sold to schools and colleges for experimental work in radio and to amateurs for experimental work.

24. Question. For what use were these tubes represented to be suitable by the Marconi Co.?

Answer. For detecting radio signals.

25. Question. Were these tubes represented by the Marconi Co. to be capable of use as amplifiers, or as oscillators?

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Answer. Not to my knowledge.

26. Question. In what manner did these tubes operate in detecting radio signals?

Answer. I believe they operated as one way valves.

27. Question. Are these two element vacuum tubes capable of operating as amplifiers?

Answer. They never operated as amplifiers for me, so far as I know.

[fol. 940] 28. Question. Have they ever been used as amplifiers in commercial or governmental work, so far as you know?

Answer. No.

29. Question. What device is used as an amplifying device in the radio and telephone arts?

Answer. The three electrode vacuum tubes.

30. Question. How did the two element vacuum tubes compare with the crystal or carborundum detector with respect to sensitivity?

Answer. As a rule, as I recall it, the carborundum crystals, I used were more sensitive than the two element vacuum tubes.

31. Question. To what extent, if at all, did the two element vacuum tubes displace the crystal or carborundum detector?

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Answer. According to my recollection, they did not displace the crystal or carborundum detector except for temporary periods where they were tried in place of crystal detectors.

32. Question. In the last part of your answer to question 5 you referred to the sensitivity of the modern three-electrode vacuum tube apparatus being such that operators now require a signal about ten times as strong as they required when crystal detectors were used. What does this indicate as to the relative sensitivity of the three-electrode vacuum tube as compared with that of earlier apparatus?

Answer. It indicates that the three-electrode vacuum tube arrangements as now used are about ten times as sensitive as the former detectors, insofar as the operator's results are obtained.

33. Question. To what extent, if at all, has the three-electrode vacuum tube displaced other apparatus in transmitters and detecting devices in the radio art?

Answer. The three-electrode vacuum tube has almost entirely displaced all other forms of detectors, and the three-electrode vacuum tube as transmitter has been displacing other transmitters during the past few years, but in just what proportion I could not say.

Cross-examination.

By Mr. Vaill:

34. Cross-question. Mr. Marriott, I believe you stated in your direct examination that you first became connected with the Department of Commerce of the United States Government in 1912. Have you been continuously employed in that Department or the Navy Department since that date?

Answer. Yes; my appointment in the Department of Commerce beginning in 1912 automatically expired when my appointment to the Navy Department in 1915 took effect.

35. Cross-question. Under whose instructions or authority were you called to testify in this case?

Answer. I was requested by Mr. Edwards to meet him here for the purpose of testifying.

36. Cross-question. As a matter of fact, you had to obtain the permission or authority of some official of the Navy Department to testify in this cause before you came here, did you not?

Answer. No; I simply took leave.

[fol. 941] 37. Cross-question. Did not your commanding officer know the purpose for which you were taking leave before you came to testify in this cause?

Answer. The particular officer who you would probably mean is my commanding officer is away and while he knows that I am to testify at some time or other, he does not know at what particular time.

38. Cross-question. Through what channel did your commanding officer know that you were to testify in this cause?

Answer. Through me. I told him about the case some time ago.

39. Cross-question. Do you know whether any official order or written permission has been issued by any official of the Navy Department instructing or permitting you to testify in this cause?

Answer. I do not know of any orders relating specifically to this case and place.

40. Cross-question. Do you know of any orders or authority relating to this case issued by any department of the United States Government authorizing or requesting you to testify?

Answer. Orders were issued to me in 1923 to report to the Department of Justice for a period of time, which reporting covers this case, in that this case was mentioned in my conferences with the Department of Justice.

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[fol. 942] 50. Cross-question. In your answer to question 5 on direct examination you stated that by use of tuned coupled circuits it was possible to hear ships on the Atlantic, although you were located in Denver Colo. In making this statement, was the tuned coupled circuit you referred to at the receiving station or were you informed that these circuit- were at the transmitting station?

Answer. The tuned coupled circuits I had in mind were the De Forest transmitters on board ships on the Atlantic. I was told what these transmitters consisted of, and I saw some of them on the vessels coming in to Galveston.

51. Cross-question. At the time of receiving the signals to which you referred, how did you know that it was from a tuned coupled circuit of the De Forest type mentioned by you?

Answer. From descriptive matter, letters, hearsay, and that they sounded like the transmitter of the same type in my immediate vicinity.

52. Cross-question. Did you know the name of the vessel which transmitted the signals to which you referred?

[fol. 943] Answer. The names of the vessels were often given in the context of the messages and the call letters were given, the call letters being assigned to the particular vessels.

53. Cross-question. Do you recollect what the particular vessel it was that transmitted the signal which you heard in Denver?

Answer. There was more than one vessel, and I do not now remember the names of any of them.

54. Cross-question. What type of receiving circuit was used by you in receiving this signal from ships on the Atlantic Coast in Denver?

Answer. Referring to defendant's Exhibit A-5, Loftin's sketch P, as I recall now, the receiving arrangement used was similar to the receiver indicated in that sketch, except that the condenser shown was connected between the lower end of coil J and the detector instead of between contact 5 and the detector; also that the other end of the antenna was connected to earth through an inductance, which was variable by making sliding contacts on the inductance.

55. Cross-question. The distance from Denver, Colo., to the ships on the Atlantic coast to which you have referred was in the vicinity of twenty-five hundred miles, was it not?

Answer. Ordinarily, I believe the ships were not quite that far away. However, some of them may have been, when they were in the vicinity of Cuba or Porto Rico.

56. Cross-question. In answer to question 5 on direct examination you stated that it had been possible since 1915 to read European stations in Bremerton, Wash., using the constant amplitude transmitters. To what type of constant amplitude transmitter did you refer in making that statement?

Answer. The one referred to in the particular year 1915 that I had in mind was of the dynamo type. I do not recall whether it was a Goldschmidt or Arco type, according to the then existing records of the type of apparatus used. The more recent one that I had in mind was that at Eiffel Tower, and I don't recall at present what type that is; I believe is an arc type.

57. Cross-question. You were aware, were you not, that during the year 1902, or thereabouts, Mr. Marconi transmitted signals by the use of a spark transmitter between the Pohldu Station in the British Isles and his station in Canada?

Answer. Do you refer to Marconi's getting the letter "S" across the Atlantic?

58. Cross-question. Yes, and to the press service established shortly thereafter.

Answer. In so far as Marconi's claim of getting the letter "S" across the Atlantic, which, I believe was the first incident claimed, I have always been more or less lost as to what to think about it, because very nearly the same time I made daily experiments with the coherer receiver on the Atlantic coast, and got such multitudes of dot letters, letter "S's by the hundreds, two dot letters in greater numbers, and one-dot letters in still greater numbers. In so far as the first alleged messages sent across the Atlantic are concerned, there have been a considerable number of statements made in print and otherwise that those same messages were sent by cable previously or simultaneously. [fol. 944] 59. Cross-question. It is a fact, is it not, that in 1902, or shortly thereafter, press service with Great Britain was maintained for several months by the use of the Marconi four circuit transmitting and receiving system through the station at Pohldu and the Canadian station?

Answer. I recall that statements somewhat similar to that have been made, but I do not know whether or not they are facts.

60. Cross-question. In giving your answer to question 8 on direct examination, in which you are asked if tuned coupled circuit transmitters are now in use for commercial or governmental work, and you answered "No," is your answer to be understood to be of the negative without regard to the means for producing the oscillations in such tuned coupled circuits, or is it to be understood as limited in some way?

Answer. What I meant was that the tuned coupled circuit transmitter as I have shown in Figure 2 of defendant's Exhibit Q-5, Marriott's sketch, is no longer in use.

61. Cross-question. In answer to question 2 on direct examination, you mentioned "some wireless telephone work for the Ashley Wireless Co." in the period prior to 1905; what did this work consist of?

Answer. Ashley got us to build quite a little apparatus according to his ideas in which, as I recall it, he tried to get high enough spark frequency or sustained waves so that it could be modulated with a telephone transmitter and intelligible by using a detector and a pair of phones at the receiver.

62. Cross-question. Did these ideas work out successfully?

Answer. Not that I know of.

63. Cross-question. Will you please state as accurately as possible the dates between which you were connected with the Marconi Wireless Telegraph Co. of America?

Answer. I do not remember the date I went with the Marconi Co., but it was the latter part of 1911, and my recollection is that I went with the Department of Commerce in October, 1912.

64. Cross-question. What was the reason for your leaving the Marconi Wireless Telegraph Co. of America?

Answer. The Department of Commerce was arranging to put on the radio inspection service, and as I had perhaps more experience in the maintenance of vessels running into New York than anybody else at that time, the Department of Commerce people talked to me a great deal about it before starting the service, and they suggested that I take the examination for inspector. I took the examination and received a telegram some time afterwards asking if I would accept appointment as inspector. I had to give a prompt answer, and I answered that I would, and then put in my resignation from the Marconi Co.

65. Cross-question. How long were you located at New York as inspector for the Department of Commerce?

Answer. As I recall, I was located at New York most of the time between October, 1912, and January, 1915.

[fol. 945] 66. Cross-question. What portion of the ships that you inspected at New York during the period last mentioned were equipped with Marconi wireless transmitting and receiving apparatus?

Answer. As I recall, most of the foreign ships were equipped with Marconi apparatus, and most of the United States ships were equipped with ex-United Wireless apparatus then owned by the Marconi Co.

67. Cross-question. Will you kindly state the types of transmitters and receivers which you found on the foreign ships which you inspected at New York, and also the types of transmitters and receivers which you found on the domestic ships during the same period of your inspection?

Answer. The transmitters included plain antenna transmitters, tuned coupled circuit transmitters, and impulse excitation transmitters. The receivers usually consisted

of a primary inductance and a separate secondary inductance, and the detectors were usually crystal detectors.

68. Cross-question. Does your last answer apply equally to the domestic ships and also foreign?

Answer. A large number of changes occurred between 1912 and 1915, and there were a great many ships. My recollection is that the answer applies to both foreign and domestic ships, but I could not say that it applies equally.

69. Cross-question. Why did you consider it necessary to examine so much at length defendant's Exhibit R-5, which I understand you have testified contains the article written by you?

Answer. I have given so little thought to the matter covered by the question during the past 10 years that I used the exhibit in an attempt to refresh my memory.

70. Cross-question. Do you find anything in defendant's Exhibit R-5 which you consider does refresh your memory as to the particular types of transmitting and receiving apparatus which you found on vessels inspected at New York during the period you were inspector at that place?

Answer. The general trend of changes indicated in the exhibit does seem to bring back somewhat clearer a general idea of what was occurring between 1912 and 1915.

71. Cross-question. Will you please state what proportion of the vessels inspected by you at New York between 1912 and 1915 had tuned coupled circuit transmitters, what proportion had impulse excitation transmitters, and what proportion had plain antenna transmitters?

Answer. I do not remember the proportions at this time.

72. Cross-question. It is a fact, is it not, that you testified as a witness for the defense in a suit brought by the United States against officials of the United Wireless Co., in which the latter were indicted for unlawful stock operations?

Answer. I was subpoenaed by both sides in that case, and as I recall it, I gave some testimony regarding the patents that I had assigned to the United Wireless Telegraph Co., and I believe it was the defense that put me on the stand for that purpose.

73. Cross-question. You recollect, do you not, that similar suits were brought against officials of the De Forest Wireless Telegraph Co. and the Collins Wireless Telegraph Co.?

[fol. 946] Answer. I have no recollection of such suits against the De Forest Wireless Telegraph Co., but I have some recollection of some such suits against the Collins Co.

74. Cross-question. During your connection with the Marconi Wireless Telegraph Co. of America in 1911 and 1912, it is true, is it not, that the effect of these suits for indictments of officials of the companies referred to in the previous question had a very depressing effect upon the business of the Marconi Wireless Telegraph Co. of America and the wireless telegraph business in general so that profits realized from the business were practically wiped out?

A. That is not the impression which I retain of what happened at that time.

75. Cross-question. Among the advances made in radio transmission subsequent to 1900 concerning which you testified in answer to question 3, is it not true that the use of higher antennae contributed to a considerable extent to increased distance of transmission?

Answer. The use of higher antennae contributed in specific cases, such as, for example, at Tuckerton, the Goldschmidt station, and at Sayville, the Atlantic Communication Co. station.

76. Cross-question. Is it not true that during the same period that the use of antennae having increased capacity contributed to the increase of distance of transmission?

Answer. The increase of capacity contributed in specific cases.

77. Cross-question. It was true, was it not, that increase in the height of the antenna and increase in the capacity of an antenna, as a general proposition, was found to increase the distance of transmission?

Answer. Leaving out consideration of some practical points, such as wave length, I believe that is true.

78. Cross-question. It is true, is it not, that during the same period that increased distance of transmission was attained by lowering the so-called ground resistance and also the antenna resistance?

Answer. That apparently was true in some cases.

79. Cross-question. Do you know of any cases where the subject-matter of my previous question was not true?

Answer. For example, on ship board the antenna resistance and ground resistance was probably about the same

from the time of the first installations through the later installations.

80. Cross-question. Do you mean by that that it had always been low or that it was not lowered?

Answer. I mean that according to my observations it apparently was not lowered.

81. Cross-question. But it is true, is it not, that it was found, as a general proposition, particularly in land stations, that a lowering of the antenna and ground resistance resulted in increased distance of transmission?

Answer. Yes.

82. Cross-question. It was also found, was it not, during the period subsequent to 1900, that an increase in the height of the receiving antenna also contributed to the distance at which signals could be received?

Answer. Leaving out the consideration of wave length and static. I believe that is true.

[fol. 947] 83. Cross-question. During that period it was found, was it not, by experiment that the distance of transmission and reception was substantially proportional to the product of the respective heights of the transmitting and receiving antennae?

Answer. Leaving out the consideration of wave length and static, I believe that is true.

84. Cross-question. It was also true, was it not, during this same period that it was experimentally determined that by using a grounded transmitting antenna and a receiving loop, the distance of reception was increased in proportion to the product of the height of the transmitting antenna and the length of wire on the loop?

Answer. Leaving out the matter of wave length, that statement seems to correspond with my experience.

85. Cross-question. Is it not true that increased signaling distances were also obtained by using higher spark frequencies, that is, of 500 cycles per second or more, instead of 60 cycles or less?

Answer. Generally speaking, I believe that is true.

86. Cross-question. Is it not true that increased distance obtained with quenched spark transmitting sets was due in part to higher spark frequencies employed in such sets?

Answer. The increased distances were apparently attained with quenched spark sets partly by the use of spark frequencies in the neighborhood of 1,000 sparks per second,

as compared with lower spark frequencies, which had been used in the earlier types of sets.

87. Cross-question. It is true, is it not, according to your knowledge of the matter, that all of the quenched spark transmitters as developed for and used by the United States Navy involved a plurality of radio frequency oscillations in the primary closed circuit, as well as in the secondary or antenna circuit?

Answer. In so far as I recollect at the present time, the radiation from the antenna circuit indicated three frequencies when I used extremely sensitive frequency measuring apparatus. However, I can not say as to the oscillations in the primary at present.

88. Cross-question. Referring to your last answer, it is true, is it not, that of the three frequencies mentioned therein, the second or middle frequency was greatly predominant over the other two as to the amount of energy radiated from the antenna?

Answer. Yes.

89. Cross-question. It is true, is it not, that when the so-called heterodyne reception is used, the operators adjust the circuits to produce a high beat note in order to obtain greater distances?

Answer. Operators to receive signals from constant amplitude transmitters use the heterodyne method to enable them to get the signals, ordinarily speaking, regardless of distance.

90. Cross-question. According to your knowledge, what is the number of cycles usually employed by operators with the heterodyne reception to receive signals from comparatively distant stations?

Answer. This varies with operators. On an average, I believe they use a sound frequency of about 750 cycles.

91. Cross-question. In your direct examination you stated that impulse excitation transmitters have given place to constant amplitude transmitters. Is it not true that a very considerable portion of the so-called impulse excitation [fol. 948] transmitters installed on commercial ships was not replaced by constant amplitude transmitters until subsequent to about the year 1915?

Answer. I believe that is true.

92. Cross-question. It is true, is it not, that there are still a considerable number of the so-called impulse excitation transmitters in use on ships at the present day?

Answer. I believe that is true.

93. Cross-question. In the year 1905, will you please state what transmitting and receiving sets you personally inspected and traced the circuits, particularly those at stations owned and operated by the United States Government?

Answer. I did not inspect any stations in 1905, so far as I recollect, that were owned by the United States Government. I recall inspecting some stations owned by the American De Forest Co. in 1905. Among those stations was one at Denver, Colo., and one at Boulder, Colo. The transmitters used were the transmitters that were typical to American De Forest and United Wireless Cos. The receivers used were similar to that shown in Loftin sketch P, defendant's Exhibit A-5, except that the condenser was connected between the lower end of the inductance and the detector, instead of between slider 5 and the detector, and the other end of the antenna was connected to the ground through a variable inductance.

94. Cross-question. Will you please state at what particular stations operated by the United States Government you examined and traced the circuits of the transmitting and receiving apparatus during the years 1906 to 1912, inclusive?

Answer. I can not recall all of them; however, I recall the naval station at North Head, Wash., and naval installations at Brooklyn Navy Yard, and at Washington, D. C.

95. Cross-question. Do you recollect who manufactured the sets at the three places you have just mentioned?

Answer. I do not remember who manufactured the sets used at North Head, Wash. At Brooklyn Navy Yard, as nearly as I can remember, I saw sets that had been manufactured by Lowenstein, Telefunken Co., Atlantic Communication Co., De Forest Radio Telephone Co. At Washington, D. C., as I recall, I saw sets that had been manufactured by those same companies and by the National Electric Signaling Co.

96. Cross-question. Do you recollect what year you saw the Lowenstein set at the Brooklyn Navy Yard?

Answer. No; I do not.

97. Cross-question. Do you recollect what year you saw the Telefunken set at the Brooklyn Navy Yard?

Answer. No.

98. Cross-question. Do you know what year you saw the set made by the Atlantic Communication Co. at the Brooklyn Navy Yard?

Answer. I believe it was 1912 that I saw that set.

99. Cross-question. Do you recollect what year you saw at the Brooklyn Navy Yard the set made by the De Forest Co.?

Answer. No.

100. Cross-question. Do you recollect what years you saw the sets at the Washington (D. C.), Navy Yard, as manufactured by the four companies above mentioned, and the National Electric Signaling Co.?

[fol. 949] Answer. My recollection is that I saw sets of those makes in or about Washington, D. C., in 1912. I do not remember just what I saw at the Washington Navy Yard. Some of these sets, as I recall it, were at Radio, Va., where they were being put into the new naval radio station.

101. Cross-question. Regarding these various sets which you have stated you saw at the Brooklyn and Washington, D. C., Navy Yards, do you know whether these sets were owned and then operated by the Navy Department, or were they under test prior to being accepted by the Navy Department?

Answer. I do not remember.

102. Cross-question. In giving your answer to question 14 on direct examination I noted that you referred constantly to the pamphlet containing defendant's Exhibit R 5. Will you please state why this was necessary?

Answer. In order to get the spelling for some of the words I was using. In paying attention to making the sketch I became more or less confused as to the spelling of some of the words.

103. Cross-question. In the answer to question 20 on direct examination you stated you tested two-element vacuum tubes or valves at the shop of the American Marconi Wireless Telegraph Co. at Cliff and Fulton Streets, New York. Do you recollect of what material the filaments and plates of those tubes were made?

Answer. I may have made a mistake when I said Cliff and Fulton Streets. It may have been Cliff and Maiden Lane. I do not now remember what the filaments and plates of those tubes were made of.

104. Cross-question. Did you have occasion to test the amount of vacuum in the two-element tubes referred to in the previous question?

Answer. No.

105. Cross-question. Do you know, or were you informed, as to where and by whom those tubes were manufactured?

Answer. In some cases I knew and in some cases I was informed, but I do not remember now the names of the manufacturers.

106. Cross-question. Do you know, or were you informed, as to whether they were made in the United States or abroad?

Answer. As nearly as I can remember, part of them were made abroad and part of them were made in the United States.

107. Cross-question. Do you remember what proportion of them was made abroad and what proportion in the United States?

Answer. No.

108. Cross-question. In answer to question 20 you stated that radio apparatus was sold from the shop or factory of the American Marconi Wireless Telegraph Co. at Cliff and Fulton Streets. What other radio apparatus did you know of as having been sold from that place in addition to two element vacuum tubes?

Answer. As I recall it, parts of the radio transmitters and radio receivers and complete radio transmitters and receivers and wave meters were sold from there for experimental purposes.

109. Cross-question. According to your recollection, while connected with the American Marconi Wireless Telegraph Co., was the volume of business done in the apparatus you have just referred to large or small?

[fol. 950] Answer. I believe it would be called a small business.

110. Cross-question. Do you have any knowledge of the profits resulting from the sale of such apparatus at the time referred to while you were connected with the American Marconi Co.?

Answer. I do not remember enough of the details to say.

111. Cross-question. During your connection with the Department of Commerce as radio inspector in 1912 to 1915, can you state to what extent foreign ships which you

inspected were equipped with receiving sets having two-element vacuum tubes or valves?

Answer. I can not remember to what extent they were so equipped at this time.

112. Cross-question. Do you remember whether any of them were so equipped with two-element vacuum tubes?

Answer. I remember that some of the ships from foreign countries had such tubes and places to use them; but, as I remember it, they had other forms of detectors; and I have not a clear recollection as to the use of the two-element vacuum tubes.

113. Cross-question. In answer to question 32 on direct examination, you stated that the requirements of the operators as to a stronger signal indicated that the three-electrode vacuum tube is about ten times as sensitive as former detectors in so far as operators' results are obtained. Is it not true that the stronger signals received through the use of three-electrode vacuum tubes are in part due to other factors, such as those referred to in previous questions, relating to the height and capacity of antennae and the greater power of the transmitting stations employed?

Answer. What I had in mind was transmitting stations which had not been changed and from which receiving operators copied business when they received audibility was only one; but after we had put in three-electrode vacuum tubes arrangements in place of the crystal detector arrangements, the operators would say that they could not receive from the other stations until the audibility exceeded about 10. In other words, the putting into use of the three-electrode vacuum tubes changed the common strength of received signals so much that operators would no longer try to receive the weak signals they had formerly received when using crystal detectors.

114. Cross-question. Is it not a fact that at the present day crystals are used to a large extent in receiving radio transmission, particularly the reception of broadcasting from the regular broadcasting stations?

Answer. Owing to the great number of tubes of the three-electrode type being used, for receiving radio broadcasting, I think it would be better to say that crystals are used to some extent, rather than to say that they are used to a large extent, according to my observation.

115. Cross-question. Is it not a fact that a considerable number of crystals are used to-day for reception of broadcasting with such crystals inserted in receiving sets or associated with the receiving sets through the use of tuned coupled circuits?

Answer. According to my observation, this year, there seem to be very few crystals used.

116. Cross-question. To what extent are you familiar with magazines dealing with amateur reception of radio broadcasting within the last year?

Answer. During the last year I think the only magazines of that nature that I have bought a copy of every month are [fol. 951] Radio Broadcast and Popular Radio and Q. S. T. However, I receive complimentary copies of other magazines from time to time, and see some of the other magazines every month.

117. Cross-question. Is it not true that many of these magazines recommend the use of crystals for broadcast reception on account of the excellent quality of the tones received by using such crystals?

Answer. One of the things that I thought I had noted during the past year was the decrease in such recommendations. As I recall it, such recommendations were very common in the magazines three years ago, and have been falling off ever since. I was caused to think of this last week when among a group of radio people, and the remark was made by one of them that he didn't want to have anything to do with a broadcast receiver combination in which a crystal detector was used, and I was surprised to note that none of those present were inclined to disagree with him, which caused me to think over the apparent falling off within the last two years.

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118. Cross-question. Is it not true that prior to the year 1909 referred to by you on direct examination as about the date that impulse excitation transmitters came into use, certain transmitting sets, such as the Slaby Arco, Siemens, and Halske, or other German transmitting sets, employed a number of short gaps in series without means for quenching the spark gap in the closed primary circuit of a transmitter?

Answer. I believe I did see some such gaps, but I do not recall who they were made by.

119. Cross-question. Is it not true that prior to 1909 the Stone Co. manufactured and sold sets which employed a number of short gaps in series without means for quenching the spark as transmitting sets?

Answer. I don't remember.

120. Cross-question. If you had available a Marconi type tuned coupled transmitter with all the electrical constants, capable of adjustment, enabling it to be operated as a quenched gap transmitter, except that the gap is of the usual or older open type, could it not be changed over to a typical quenched spark transmitter simply by using a sufficient forced cooling of the gap to quench the spark, such as by blast of air?

Answer. I don't know.

121. Cross-question. Are you a member of the Institute of Radio Engineers?

Answer. Yes.

122. Cross-question. Have you taken part in the adoption of standardization rules by that organization during the last 10 years.

Answer. I don't recall that I have been on the standards committee, during the last ten years. However, I did have something to do with helping to write some definitions during the past year.

[fol. 952] 123. Cross-question. It is true, is it not, that the standardization rules of the Institute of Radio Engineers are accepted and published by other similar societies, such as the American Institute of Electrical Engineers, particularly as to definitions of terms relating to the radio art?

Answer. I think so.

124. Cross-question. What standing, according to your knowledge of the matters, do the Institute of Radio Engineers and the American Institute of Electrical Engineers have as scientific organizations?

Answer. As engineering organizations, I believe they stand first in radio and electrical engineering.

(The examination by counsel being concluded, the witness, in compliance with the rule of the Court requiring him to state whether he knows of any other matter relative to the claim in question, and if he does to state it, says he does not.)

*Deposition of Frederick M. Sammis, for defendants, taken
at New York City on the 6th day of May, A. D. 1925*

Claimant's counsel, Edward W. Vaill, Esq.; defendant's counsel, Clifton V. Edwards, Esq.

FREDERICK M. SAMMIS, having been produced as a witness on behalf of defendants, was by me sworn before any question was put to him to tell the truth, the whole truth, and nothing but the truth, relative to the said cause, and thereupon deposed and said that his name was Frederick M. Sammis; that his occupation is exporter; that he is of mature age; that his residence is 890 Degraw Avenue, Newark, N. J.; that he has no interest, directly or indirectly, in the claim in controversy; and that he is not related to the plaintiff.

And thereupon the said Frederick M. Sammis was examined by counsel for the defendants, and in answer to interrogatories testified as follows:

Direct examination.

By Mr. Edwards:

1. Question. Mr. Sammis, a few weeks ago I called you on the telephone and requested you to appear here and give testimony voluntarily, did I not?

Answer. Yes.

2. Question. And you declined to appear without a subpoena?

Answer. Yes.

3. Question. And you are here now in response to a subpoena served upon you?

Answer. Yes.

4. Question. You gave testimony, did you not, as a witness in the case of Marconi Wireless Telegraph Co. of America against Kilbourne & Clark Manufacturing Co. in a suit in equity on the Marconi patent No. 763772, pending in the United States District Court for the District of Washington, in or about the year 1916, did you not?

Answer. I don't know it by that exact structure, but I do know I gave testimony some years ago in a suit against Kilbourne & Clark Co.

[fols. 953-954] 5. Question. I have here a printed copy of the record on appeal in the case referred to and show you the same, and call your attention to the deposition beginning at page 995 of that record. Are you the Mr. Sammis who gave that deposition?

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Answer. Yes.

6. Question. What has been your connection with the art of radio telegraphy and telephony?

Answer. Beginning in 1901 or 1902 I joined the forces of the newly organized American Marconi Co. and continued with it for 13 or 14 years, the last 6 or 7 years as its chief engineer; then 2 or 3 years with the American Radio & Research Corporation as its commercial manager; then followed about 6 years with the Westinghouse Lamp Co. as its foreign sales manager; and for the last 2 years in my own business as exporter, largely of radio and electrical products.

7. Question. Will you give the full name of the American Marconi Co. to which you referred?

Answer. Marconi Wireless Telegraph Co. of America.

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[fol. 955] 27. Question. In or about 1902 what type or types of transmitting apparatus was used by the Marconi Co.?

Answer. Most generally the 10" spark coil with one side of the spark connected to the antennae and the other side to the earth. Just about that time coupled circuits were developed, and I believe that I made personally, with my own hands, the first oscillation transformers that the Marconi Co. used in this country. That was before I actually joined the company, I being at that time store manager for J. H. Bunnell & Co., and Mr. Bradfield and Andrew Gray, of the London Marconi Co., came into our store and asked me to make such oscillation transformers for them, and it was done.

28. Question. In the Kilbourne & Clark case, according to the printed record, page 996, in answer to question 9, you testified as follows:

"In 1902 practically all of the transmitters then in operation were of the plain aerial type, in which the antennae was directly shocked by the spark therein. Later a type of

coupled circuits was used which contained a Tesla coil inserted in the antennae, in lieu of the spark gap, and in the primary circuit of this Tesla coil was connected the spark gap and the condenser."

To the best of your recollection was that testimony true?

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Answer. Yes.

29. Question. Will you please make sketches showing generally and diagrammatically these two types of apparatus and describe them? Please first make the type that you have called the plain aerial?

[fol. 956] Answer. In attempting to do this I shall do it to the best of my ability, but it is a long while since I have made these sketches and I have been out of touch with the ultratechnical side of the matter. I am sure I can draw the plain aerial type, however. I have done so, and I have marked the antennae A, the ground B, and the spark gap C; I have also made the tuned circuit.

Mr. Edwards: The sketches made by the witness are offered in evidence by the defendants, that of the plain aerial type being marked "Defendants' Exhibit T-5" and that of the coupled type being marked "Defendants' Exhibit U-5."

30. Question. Will you now briefly describe the sketches T-5 and U-5, identifying the parts by reference letters?

Answer. Sketch T-5 I have shown the antennae by letter A, spark gap C, and ground B. The sketch U-5 I have shown the antennae A, the secondary coupled coil as F, and the ground B; I have shown the spark gap as C, the condenser as D, and the associated coil of the coupled coil as E.

31. Question. Will you please explain generally how and where each of the two types of apparatus shown in T-5 and U-5 were used by the Marconi Co.?

Answer. That is a large question. They were used generally on ship and shore stations.

32. Question. Will you add to the two sketches, U-5 and T-5, the Rhumkorf coil or other apparatus for producing the spark as used in these transmitters?

Answer. Yes. I have done so and marked them D in the case of T-5 and G on sketch U-5.

33. Question. To what extent was it customary in practice for the operators to connect the Rhumkorf coil in the type of transmitter shown in U-5 directly between the antennae and the earth?

Answer. I do not think that is a question I can answer, except as a matter of supposition.

34. Question. Did the apparatus shown in the defendants' Exhibit U-5 displace the type of apparatus shown in Exhibit T-5?

* * * * * *

Answer. The fact of the matter was that the same coil was used in both instances, and it would be an easy matter for an operator to connect the antennae and ground directly to it, if he desired to do so.

35. Question. Was there any reason why in practice the operator would find it advantageous to do so?

Answer. If I remember correctly, Mr. Marconi said himself it worked further.

36. Question. Will you explain in what way it worked further?

Answer. I don't know as I understand the question.

37. Question. What meaning was conveyed by Mr. Marconi's expression "worked further"?

Answer. I assume more miles with the same amount of energy.

38. Question. In the practice of the Marconi Co. did the type of apparatus shown in sketch U-5 displace the type of apparatus shown in the sketch T-5?

Answer. From the very essence of things it could not; all that was required to make T-5 was to disconnect the tuning apparatus from G in U-5. They were identically the same coil in both instances.

[fol. 957] 39. Question. In or about 1902 to what extent was the plain aerial type used by the Marconi Co.?

Answer. Which Marconi Co.?

40. Question. The American Marconi Co., of which you were chief engineer.

Answer. Not at that time.

41. Question. In your testimony in the Kilbourne & Clark case, on page 998, in answer to question 12 you testified as follows:

"The commercial apparatus used by the Marconi Co. and companies generally in those days consisted of a Rhum-

korf coil energized either from direct dynamo current or storage batteries, and the plain aerial type was almost universally used for the handling of all commercial business from ship to shore and shore to ship."

Is that in accordance with your present recollection?

Answer. Yes; the reason I could not answer your previous question was that in 1902, if my memory serves me, the Marconi Co. of America had no stations, or very few.

42. Question. To what stations were you referring in giving your testimony in the Kilbourne & Clark case?

Answer. The stations belonging to the Marconi International Marine Communications Co., which was the London company, and perhaps some of the Belgian company stations.

43. Question. What would you say as to whether or not, when the coupled circuits were added, it became common practice for the operators to connect the Rhumkorf coil directly between the antennae and the earth?

Answer. We used to hear rumors that it was done, and I have known of cases where better results were secured that way.

44. Question. Continuing your answer to question 12 in the Kilbourne & Clark case, you testified:

"Later, when the coupled circuits were added, the Rhumkorf coil, key, battery, etc., were identical, and it was common practice for the operators to connect said Rhumkorf coil directly between the antennae and the earth, because they found it very much more efficient than the coupled set that had been furnished."

Is that in accordance with your present recollection?

Answer. I would say that if I said it at that time it was my belief at that time. I have no recollection now that would help the matter.

45. Question. You further testified in the same answer:

"Practically the only time that the coupled sets were used was when from storm or damage the antennae insulation became so low as to prohibit the spark at B, as shown in Exhibit No. 13. The efficiency of these plain aerial sets was common knowledge throughout the entire Marconi service and it became quite a problem to insure that the operators did not use them as plain aerial sets even after

the coupled sets were furnished. In fact, operators were frequently reprimanded for this practice. The company found it impossible to govern their actions when at sea or even at land stations.

"The objection to the use of the plain aerial was due to the somewhat severe strain of the antennae insulation and a certain tendency of the coils to break down.

[fol. 958] "At the shore stations of the Marconi Co. for a considerable number of years after 1902 the plain aerial was used exclusively, or almost so, on account of its high efficiency.

"The station at Sagaponack, N. Y., is a particular example. This station operated with an inductance coil sparking directly into the antennae and earth up to the time the plain aerial was prohibited by law."

Did you so testify; and if so, is that testimony in accordance with your present recollection?

Answer. I would say that if I testified to it at that time it was in accordance with my belief at that time. I have not any present recollection that would help the matter, after 23 years.

46. Question. Have you any reason to believe that you did not so testify or that any of the matters stated in the testimony which I have just read to you is not true?

Answer. No.

47. Question. Did you have any personal knowledge of the reprimanding of operators and of the practice of the operators as referred to in the above extract from your testimony?

Answer. The testimony says that I did; therefore I must have had.

48. Question. How was it possible for an operator to work his transmitter, as provided by the Marconi Co., so as to bring the spark gap directly into the aerial circuit?

Answer. Usually both leads from the spark gap to the condenser and inductance were disconnected and the antenna and ground substituted in their place.

49. Question. The type of apparatus referred to in the last question was that shown by Exhibit U-5, was it not? →

Answer. Yes.

50. Question. Up to that time was the plain aerial construction shown in the sketch T-5 used by the Marconi Co.?

Answer. If you will excuse me, the question is not well

put; it is rather ambiguous, because it was not a matter of construction; it was a matter of connection and use. I would be unable to say at just what time it was officially forbidden to work with the spark in the antennae or how long after such time operators made a practice of doing it.

51. Question. Was the type of apparatus illustrated in sketch T-5 still in use in 1916?

Answer. I think only as auxiliary for operation from storage batteries in emergency cases.

52. Question. Why was this?

Answer. Perhaps there were several reasons. I would put first economy, because such equipment was already on the vessels and could be utilized; second, perhaps because it was pretty efficient with comparatively small expenditure of power. I should add, however, that both types were left on the ships, if I remember rightly—both U-5 and T-5.

53. Question. Why was the type T-5 used only for emergency purposes?

Answer. They were beginning to fit ships with power apparatus in those days which operated from the ship's dynamos, and this set that you have asked about operated from storage batteries which would be available in case the ship's current supply failed.

[fol. 959] 54. Question. Was not the reason the type T-5 was used for emergency purposes only because of the radio act of 1912?

Answer. I do not remember that.

55. Question. In your testimony in the Kilbourne & Clark case, with reference to this plain aerial type, you testified in answer to question 15, page 999, as follows:

"It is still in use. I would add, however, that it is only now used for emergency purposes on some ships, on account of the radio act prohibiting its general use."

Did you so testify; and if so, have you any reason to doubt the correctness of that testimony?

Answer. I have no reason to doubt it.

56. Question. Up to 1908 or 1909 what type of transmitting apparatus was used exclusively, or substantially so, by the Marconi Co.?

Answer. I would say that both types shown in T-5 and U-5, although I am not positive about dates.

57. Question. Referring to your testimony in the Kilbourne & Clark case, in answer to question 16, having ref-

erence to the type as shown in Exhibit T-5, the plain aerial type, you testified, page 999, as follows:

"Up to what time was the plain aerial construction shown in defendant's Exhibit No. 13 used by the Marconi Co. in its commercial transmission work?

"Answer. Almost exclusively up until 1908 or 1909, and to a considerable extent after that also."

Have you any reason to doubt the correctness of that testimony?

Answer. No.

58. Question. As the apparatus of the transmitter of the type shown in defendant's Exhibit U-5 was made and used by the Marconi Co. was the inductance and capacity of the primary circuit made adjustable?

Answer. The capacity could be changed, but the inductance usually not, although both types were used.

59. Question. Was the capacity which was used an adjustable capacity?

Answer. It usually consisted of a collection of Leyden jars and, of course, more or less could be connected, if desired; in that sense it was adjustable.

60. Question. Have you any reason to question the accuracy of your answer to question 18 in the Kilbourne & Clark case referring to these sets, as follows, page 1000:

"The sets as made and used prior to 1907 or 1908 were nonadjustable, the Tesla coil had no adjustable connections. In other words, a fixed primary and fixed secondary and a tray containing a fixed number of Leyden jars was supplied and used."

Answer. No.

61. Question. Is the tray of Leyden jars represented on your sketch U-5?

Answer. Yes; under the letter D.

62. Question. What, if anything, on the defendant's Exhibit U-5 represents the Tesla coil?

[fol. 960] Answer. E and F.

63. Question. When, if ever, was the capacity and inductance of the apparatus of the type illustrated in defendant's Exhibit U-5 made adjustable by the Marconi Co.?

Answer. When they wanted to change the wave length.

64. Question. In or about what years did the Marconi Co. provide means in these sets for making the inductance and the capacity variable?

Answer. They had been made fixed in the first instance and for general ship work because it was found more convenient to put them in as units and make whatever adjustments on the antennæ that might be necessary to keep them in tune.

65. Question. Later, were the sets provided with means whereby the inductance and the capacity could be made adjustable?

Answer. Some sets were made that way; I can not remember in just what years, or whether it was later or before.

66. Question. Did the Marconi Co. at a later period provide taps on the transformers for varying the inductance and means for varying the position of the plates of the condenser in order to vary the capacity of these sets?

Answer. In certain land stations where power was used, in other words alternating current and the high-tension transformers in lieu of the Ruhmkorf coil. In those instances it was usually found more convenient to make both the open and closed circuits readily adjustable without reference to their inductance and capacity.

67. Question. To the best of your recollection, when did the Marconi Co. first make the inductance adjustable by providing adjustable taps on the transformer, for example?

Answer. I think I made them adjustable myself, personally, in the early days, perhaps as early as 1903, winding them of bare wire and clipping the lead on in any desired position.

68. Question. I quote the following from your testimony, page 1000 of the record, in the Kilbourne & Clark case:

"21. Question. When, if ever, was the capacity and the inductance of the apparatus, defendant's Exhibit No. 14, made adjustable, as used by the Marconi Co.?"

"Answer. To the best of my recollection, about 1907 or 1908, when a few sets were put up having adjustable taps on the secondary of the Tesla coil G, Exhibit No. 14. I remember very distinctly that one of the early sets of this nature was installed at Siasconsett, Mass., by myself."

I also show you defendants' Exhibit No. 14, referred to in this answer, which sketch appears on page 5254 of the printed record in the Kilbourne & Clark case. Does this

testimony and the exhibit refresh your recollection as to when the Marconi Co. first made the inductance adjustable in its transmitters?

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Answer. I would say that perhaps in this case mentioned by you it was the first instance, or perhaps an early instance of where the inductance was made adjustable in a commercial installation. I had personally made them adjustable myself before that time, perhaps in shop or experimental work.

[fol. 961] 69. Question. Is the testimony above quoted true, according to your personal recollection?

Answer. With the amplified statement I have just made, I would say it is.

70. Question. That is, that it refers to commercial sets put out by the Marconi Co.?

Answer. Yes; to the best of my recollection; it is a long time ago.

71. Question. To the best of your recollection, how many sets of adjustable apparatus were put out by the Marconi Co. in 1909?

Answer. I would not dare hazard a guess.

72. Question. Referring again to your testimony in the Kibbourne & Clark case, page 1000, question 22 and its answer are as follows:

"22. Question. In 1909 how many sets of apparatus thus made adjustable were in use by the Marconi Co.?"

"Answer. I should say not over a half dozen all told."

Have you any reason to question the giving of this testimony or its accuracy?

Answer. No.

73. Question. Were you familiar with the apparatus formerly used by the United Wireless Telegraph Co.?

Answer. I presume I was at the time. You mean receiving or transmitting apparatus, or both?

74. Question. Both.

Answer. Not very familiar with their early receivers.

75. Question. Is that company still in existence?

Answer. No.

76. Question. Do you know what became of it?

Answer. It went out of existence.

77. Question. Do you know what became of its assets?

Answer. I don't think so.

78. Question. Do you know whether or not the Marconi Co. purchased the assets of the United Wireless Co.?

Answer. They took over their ships; that I remember now; and shore stations.

79. Question. Did the Marconi Co. acquire any transmitters formerly made by the United Wireless Co.?

Answer. That I do not remember at this time, except in taking over the ships they took over all the equipment.

80. Question. Do you recollect about when the Marconi Co. acquired these transmitters from the United Wireless Co.?

Answer. I think about 1912.

81. Question. Did the United Wireless Co. use transmitters of the two-circuit coupled type?

Answer. I think that they used an autotransformer, which produced the same result.

82. Question. Did apparatus of that character come into the possession of the Marconi Co. from the United Wireless Telegraph Co. when the Marconi Co. acquired the sets above referred to?

Answer. Yes.

83. Question. Do you know how many of such sets there were?

Answer. Several hundred, I would say.

84. Question. What became of those sets?

Answer. When?

85. Question. After being acquired by the Marconi Co. [fol. 962] Answer. I guess they were used; for a while, anyway.

86. Question. What did the Marconi Co. do with the sets?

Answer. Why, on some of them I think we made two-coil transformers of them, instead of autotransformers, in order to improve the tuning.

87. Question. Were a number of these sets continued in use in the vessel and shore stations where they had been installed by the United Co.?

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88. Question. As unaltered.

Answer. I don't remember.

89. Question. Were all of the sets acquired from the United Wireless Co. altered by the Marconi Co.?

Answer. A good many of them were; I don't know whether they all were or not.

90. Question. Were any of the unaltered sets in use by the Marconi Co. up to the time you left that company?

Answer. That I do not remember either.

91. Question. In your testimony in the Kilbourne & Clark case, in answer to question 26 et seq., you testified as follows:

"26. Question. Did the United Wireless Co. use transmitters of the two-circuit coupled type?

.
"Answer. Yes.

"27. Question. Did any apparatus of that character come into the possession of the Marconi Co. from the United Wireless Telegraph Co. when the Marconi Co. took over the assets of the United Co.?

"Answer. Yes; several hundred sets.

"28. Question. What became of this apparatus?

"Answer. It was continued in use after the vessel and shore stations where it had been installed by the United Co., and a good deal of it is still in use.
.

"29. Question. Was any of this apparatus obtained from the United Co. in use by the Marconi Co. when you left the latter company in 1915?

"Answer. A large quantity of it; yes."

Does the reading of this testimony refresh your recollection sufficiently to say whether or not the apparatus so acquired by the Marconi Co. and referred to in the above testimony continued in use unaltered until the time when you left the Marconi Co.?

Answer. All I can say is that the testimony given at that time was undoubtedly true.

92. Question. Did you ever make any tests or comparisons of the plain aerial transmitter, as shown in defendants' Exhibit T-5 and the coupled type shown in defendants' Exhibit U-5; and if so, what were the results of such tests or comparisons?

Answer. I may have made such tests, but they have gone from my memory now.

93. Question. In answer to question 30, at page 1002 of the printed record in the Kilbourne & Clark case, you testified:

[fol. 963] "I have personally made such tests myself and if great many tests were made under by directions, and reports of results supplied to me while I was chief engineer of the Marconi Co."

Does this refresh your recollection as to whether or not you made tests or comparisons of the plain aerial type of transmitter with the coupled type?

Answer. No.

94. Question. Have you any reason to believe that the testimony above given by you in the Kilbourne & Clark case was incorrect?

Answer. No.

95. Question. Do you recall whether or not in 1907 or 1908 it began to be apparent that the practice of sticking a coupled set and a Tesla coil between the antennæ and the earth was not proving efficient?

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Answer. I do not recall it.

96. Question. Were you familiar with the tests made on the *Caronia*?

Answer. Yes; now that you recall it.

97. Question. Will you state what those tests were and what the tests showed?

Answer. In those days we had a man on the *Caronia* who was a real character; his name was H. G. Watterson; he had in those days what is now known as the D X bug, which means a mad scramble after distance. I remember now that Watterson did some extremely extraordinary things on the *Caronia* with a 10-inch coil. It used to be said that Watterson could not hear any station that was closer than a thousand miles. He did succeed in negotiating some very long distances with a plain aerial transmitter. I saw him in Egypt only two or three years ago and he remembered them very well, as we both did. As previously stated, the tests were by means of a plain aerial transmitter, and perhaps they showed that under certain conditions or perhaps under certain handling, this type of transmitter was very efficient.

98. Question. Do you recall that with the plain aerial structure Mr. Watterson was able to negotiate distances over a thousand miles?

Answer. Yes.

99. Question. And that later, when this same vessel was furnished with a 5-kilowatt tuning set, the same operator could not secure a distance greater than that secured with the Rhumkorf coil equipment?

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Answer. I would say that he said he could do it.

100. Question. The Rhumkorf coil equipment there referred to is the plain aerial type, is it not?

Answer. Yes.

101. Question. Do you recall a series of tests that were conducted in or about 1905 or 1906 directed by Mr. Bradfield, the former chief engineer of the Marconi Co., along this line?

Answer. I don't remember.

102. Question. Tests at the stations at Sagaponack and Babylon, N. Y.?

[fol. 964] Answer. I think maybe I do now, if they had reference to the loading of an antennæ and a directional antennæ.

103. Question. Do you recall that Mr. Bradfield was unable to negotiate between those two stations with the tuned set, whereas later it was found possible to work between the same stations by the use of the plain aerial?

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Answer. I believe so, although that might have been due to any one of a number of causes.

104. Question. I quote the following question and answer from your testimony, beginning at page 1002 of the printed record in the Kilbourne & Clark case, and ask you to say whether or not, to the best of your recollection, the facts stated therein are true:

"30. Question. Did you ever make any tests or comparisons of the plain aerial transmitter shown in defendant's Exhibit No. 13 with the coupled type shown in defendant's Exhibit 14; and if so, what were the results of such tests or comparisons?

"Answer. I have personally made such tests myself and a great many tests were made under by directions, and re-

ports of results supplied to me while I was chief engineer of the Marconi Co.

"In 1907 or 1908 it began to be apparent that the practice of sticking a coupled set and a Tesla coil between the antennæ and earth, which in almost every case was widely different, having reference to the aerial particularly, was not proving efficient; the same Tesla coil and condenser would be used more or less regardless of the type of antennæ used. This was doubtless one reason why the plain aerial worked better, but the principal reason is that the plain aerial itself is without any possible question the more efficient.

"I remember that Mr. Marconi in his Nobel prize lecture very clearly makes the statement that the plain aerial is very much more efficient than any type of circuit in which a condenser is used, and he refers therein to certain tests made by the steamship *Caronia*.

"I am also familiar with the tests made by the *Caronia*. The operator at the time, named H. G. Watterson, and for quite a long period of time thereabouts, transmitted from the *Caronia* with a plain aerial structure and was able to negotiate extremely long distances, some of them were over a thousand miles, all of them with plain aerials.

"Later, when this same vessel was furnished with a 5-kilowatt coupled and tuned set, and the same operator placed on board, the average of distance secured was not greater than that secured with the Rhumkorf coil equipment.

"I also remember very distinctly a series of tests that were conducted, if I remember correctly, in 1905 or 1906, which former chief engineer of the Marconi Co., Mr. W. W. Bradfield, directed.

"The stations at Sagaponack, N. Y., and Babylon, N. Y., were 60 miles apart, separated by low marshes and the waters of the Great South Bay, and the first so-called tuned set, using an alternating current generator to energize it, was installed at each of these stations.

"Tests continued for many months and ended in failure. The amount of power used was from 1 to 2 kilowatts.

"Later it was found possible to work between these stations by the use of plain aerials and the simple substitution of a Lodge coil in the antennæ.

[fol. 965] "About two years ago and for some time prior thereto the Department of Commerce, which has jurisdic-

tion over the wireless installations in the United States, began to agitate with the Marconi Co. against the use of plain aerial sets for emergency purposes on shipboard, holding that mechanical troubles with the vibrators and the possible difficulty with insulation of the antennæ might prove disadvantageous in case of emergency.

"This witness personally represented to the department that if the plain aerial auxiliary sets were tuned they would be much less efficient and would therefore be unable to comply with the law requiring that they work 100 miles.

"However, a series of tests were carried out by the United States Government in which these same plain aerial auxiliary sets were tuned, and it was well demonstrated that the average percentage of efficiency when tuned was only about 60 per cent of that when they were using plain aerials. As a result, they were allowed to remain plain aerial until the contracts expired under which they had been installed.

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Answer. They are.

105. Question. In this Sagaponack-Babylon test to which you have just referred, what was the relation between the power used when the tuned coupled circuits were used and when the plain aerial type was used?

Answer. If I remember right, the power type used about 2 kilowatts; I do not think so much as that was used in the Rhunkorf coil.

106. Question. Can you state approximately what these amounts were in the respective tests?

Answer. I think not.

107. Question. In answer to Question 31 in the Kilbourne & Clark case, page 1004, with reference to this Sagaponack-Babylon test, you testified:

"I personally conducted some of the tests myself under Mr. Bradfield's direction, built a large part of the apparatus myself, and was on the ground at both stations during the tests. Usually the amount of power of the tuned set, as I have said, was between 1 and 2 kilowatts. With the induction coil plain aerial, certainly not over one-half Kilowatt, usually less."

Does that refresh your recollection as to the amounts of power used in the tests?

Answer. I would say that if I testified to that effect at that time, it was undoubtedly true.

108. Question. You have no reason to doubt that you did so testify?

Answer. No.

[fol. 966] 109. Question. Can you give the amounts of power used in the two types of apparatus in the *Caronia* tests?

Answer. I know that Watterson had a 5-kilowatt English set on board; just how much current he put through that coil nobody but himself knew.

110. Question. By "English set," which set do you mean?

Answer. The coupled set.

111. Question. In the Kilbourne & Clark case, with respect to this matter, at page 1004 you testified as follows:

"32. Question. I ask you the same question with reference to the installations on the S. S. *Caronia*, first, when the plain aerial was used and, second, when the coupled tuned circuit was used?

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"Answer. On the *Caronia* the amount of power with the plain aerial was somewhat larger than any other plain aerial ship set owing to a special form of break used by the operator. This operator reported to me regularly upon the termination of each voyage in New York and submitted to me reports signed by the captain and the chief officer of the ship, varifying the various positions and distances. The amount of power used on the vessel for the tuned set was 5 kilowatts.

"I should judge that the ratios in these cases would be about three-quarters of a kilowatt for the plain aerial and 5 kilowatts for the tuned sets."

Have you any reason to question the accuracy of that testimony?

Answer. No.

112. Question. Were you familiar with the installations of the Marconi apparatus on the steamship *Caronia*?

Answer. Fairly so.

113. Question. Was it a part of your duty to attend to the repair and upkeep of all of the Marconi wireless apparatus on all vessels coming into New York at that time?

Answer. The emergency repairs; yes.

114. Question. Would these duties include the ordinary inspection, repair and upkeep of the apparatus on the *Caronia*?

Answer. I would say emergency repairs and, perhaps, regular inspection. I mean by that that the London company did not like the size of our bills, so we would keep at a minimum all repairs.

115. Question. In your testimony in the Kilbourn & Clark case, at page 1005, in answer to question 34, you testified as follows:

"34. Question. You have spoken of tests resulting in comparative efficiency of 60 per cent; on what is this comparison of efficiency based?

"Answer. It is based upon my own personal observation in various tests that I have made at stations of the Marconi company during my long period of service with them, and also on the various results reported to me."

Does that testimony refer to the comparative tests between the plain aerial type and the coupled type, and have you any reason to question its accuracy?

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Answer. I would say that it did refer to such comparison of types, and I have no reason to question its accuracy.

[fol. 967] 116. Question. Did the Marconi company while you were employed by it use transformers of the impulse excitation type?

Answer. I guess you had better describe one of those animals to me.

117. Question. Were you familiar with the type of apparatus put out by certain German companies and known as the quenched-gap type of apparatus?

Answer. Yes.

118. Question. In your answer to question 37 in the Kilbourne & Clark case, at page 1006, you testified as follows:

"37. Question. Did the Marconi company while you were employed by it use transmitters of the impulse excitation type?

"Answer. Yes."

How did the type of apparatus referred to in this testimony just quoted as the impulse excitation type compare with the so-called quenched-gap type of apparatus?

Answer. I would not dare make a comparison at this late date.

119. Question. Could you make a sketch generally illustrating the quenched-gap type of apparatus, to which reference has just been made?

Answer: I prefer not to, because I would feel that it might not be correct.

120. Question. What type of apparatus did you have in mind in answering the above-quoted testimony in the Kilbourne & Clark case with reference to impulse excitation type?

Answer. I don't remember.

121. Question. Do you recall that when you were with the Marconi company reports were heard of the efficiency of a new type of apparatus put out by some of the German companies?

Answer. Yes.

122. Question. Do you recall about what time this was?

Answer. No.

123. Question. Do you recall investigating these reports?

Answer. No.

124. —. Did you employ a young man by the name of Proctor to investigate this matter?

Answer. Yes.

125. Question. What was the nature of his investigation and report?

Answer. I don't remember accurately enough to describe it, except that he was on research work.

126. Question. As a result of this investigation did the Marconi company design and build apparatus of the quenched-gap type?

Answer. It designed and built apparatus of the quenched-gap type; but I do not know whether it was the result of Proctor's research or not.

127. Question. How did these quenched-gap sets built by the Marconi company compare in efficiency with the coupled and plain aerial types illustrated in sketches T-5 and U-5?

Answer. I do not know that I ever compared them; I don't remember that I did. It was natural since they were [fol. 968] power sets, that they should have had a greater range than the other type, which was generally operated from storage batteries.

128. Question. Reading from the record, page 1007 of the Kilbourne & Clark case, it appears that you testified as follows:

"38. Question. To what extent was that type of transmitter used by the Marconi company, and when did it begin using them?

"Answer. About 1911 I began to hear various reports of the remarkable efficiency secured by a type of German apparatus called the 'singing spark.' I investigated some of these reports and found them to be authentic, and requested that my superiors permit me to build such sets, to which they agreed. I employed a young man named Proctor, who spent several months of long, arduous labor in perfecting a set of the impulse excitation type. Considerable difficulty was experienced in so building and designing the several units so as to overcome the inefficiency of the Marconi four-circuit tuning arrangement, whereby a very broad wave was usually emitted. Work was continued on the impulse transmitter, and finally it was developed to such a state of efficiency that a very large quantity of it was sold to the United States Government.

"Later the Marconi service began to be criticized for the large quantity of United-Wireless-Marconi type transmitters that it was using, and it finally decided to build about 200 of the impulse transmitters and to scrap or sell off at bargain prices the United Wireless apparatus, and older apparatus of that type. These 200 sets were for the most part to be installed at the various ship and shore stations of the Marconi service, and a considerable number had already been installed at the time I left the Marconi service.

"When these equipments were first tested out it was found that a half kilowatt transmitter of the impulse type would put as much current into the antennæ as would a 2-kilowatt set of the Marconi two-circuit tuned type. The result in distances also bore about the same ratio."

Did you give such testimony, and if so, have you any reason to question the accuracy of it?

Answer. I understood in your previous question that you wanted me to compare the impulse type transmitter with the plain aerial. I gave the testimony which you read, I presume, and I have no reason to doubt its accuracy.

129. Question. Is the German apparatus here referred to the type of apparatus commonly known as the quenched-gap type?

Answer. I would say so; yes.

130. Question. Which of these sets gave the greater distance? That is to say, the Marconi tuned circuit type or the quenched-gap type?

Answer. You mean for an equivalent amount of power in each?

131. Question. Yes.

Answer. I would say the quenched-gap type was more efficient.

132. Question. Approximately how much more efficient?

Answer. Considerably; I would not want to mention any exact percentage.

133. Question. Would you say that the quenched-gap type is nearly double the efficiency of the coupled-circuit type?

Answer. Under certain circumstances I would say yes.

[fol. 969] 134. Question. In referring to efficiency, do you have in mind the distances to which the sets will transmit?

Answer. Yes.

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[fol. 970] 145. Question. Are you familiar with the Fleming patent No. 803684, a copy of which I show you?

Answer. Yes, reasonably so.

146. Question. To your knowledge did the Marconi company ever make or use or sell any of the arrangements shown in the drawings of that Fleming patent?

Answer. Yes.

147. Question. Connected in circuits as shown in the drawings?

Answer. That I could not say. I had particular reference in my last answer to the manufacture of the tubes themselves.

148. Question. Did you have any knowledge of any of such tubes sold by the Marconi company in connection with the circuits such as shown in the drawings of the Fleming patent shown you?

Answer. I do not remember that I did.

149. Question. You testified as a witness in the case of the Marconi Wireless Telegraph Co. of America against the De Forest Radio & Telephone & Telegraph Co. in the Dis-

trict Court of the Southern District of New York, based on the Fleming patent, did you not?

Answer. I think so.

150. Question. I have before me a printed copy of the record in that case in the circuit court of appeals, and on page 166 I find the following testimony:

"7. Question. To your knowledge, did the Marconi company ever make or use or sell any of the arrangements shown in the drawings of the Fleming patent in suit?

"Answer. It did not.

"8. Question. At a radio receiving station or for any purpose?

"Answer. It did not."

Did you so testify, and if so, was such testimony substantially correct?

Answer. If the question refers to the tube and the exact arrangements shown in the drawings in patent 803684, I would say the answer was correct.

151. Question. I call your attention to a diagram marked "Plaintiff's Exhibit Diagram No. 1," appearing at page 2317 of the printed record on appeal in the Marconi *v.* De Forest case just referred to, and ask if the Marconi company made and sold apparatus employing the Fleming tube in the circuits shown in that diagram?

Answer. I would assume that it did; yes.

152. Question. When did the Marconi company commence to make, use, and sell apparatus embodying the circuits shown in that diagram?

Answer. I could not say from memory.

Mr. Edwards, Defendants' counsel offers in evidence the diagram referred to, and the same is marked "Defendants' Exhibit V-5."

By consent a photostat copy of the diagram will be substituted for the original and marked in evidence by the commissioner.

[fol. 971] 153. Question. In the De Forest record just referred to I find on page 166, the following:

"9. Question. I show you a blueprint marked 'Plaintiff's Exhibit, Diagram No. 1,' forming part of the stipulation marked 'De Forest Exhibit R,' and which the Marconi com-

pany admits in that stipulation that it used. When did the Marconi company first commence to use the detector organization shown on the right-hand part of the drawing, diagram No. 1?

"Answer. Early in 1910."

Does that refresh your recollection in any way as to when the Marconi company began the use of the apparatus and circuits as shown in this diagram No. 1?

Answer. Not particularly; but if I testified to that effect it was undoubtedly true.

154. Question. To what extent was the detecting organization, as shown in the diagram No. 1, used by the Marconi company, and for about how long?

Answer. I do not believe I can tell you the exact years.

155. Question. Can you say about how many of such sets were built by the Marconi company?

Answer. No.

156. Question. Can you give this number approximately?

Answer. The thing has entirely gone from my mind; it would be a guess if I did.

157. Question. Was the number large or small?

Answer. I would say it was not very large.

158. Question. I find at page 167 of the printed record in the De Forest case the following testimony:

"10. Question. To what extent was that detecting organization used and for how long about?

"Answer. To the best of my recollection the company built from 50 to 75 such sets, such organizations, and they continued in use until 1913."

Does this refresh your recollection with regard to this matter?

Answer. No.

159. Question. Did you so testify, and was such testimony correct when given?

Answer. If I gave it, it was correct when I gave it. I do not remember giving it in just those words.

160. Question. Have you any reason to suppose that you did not give the testimony in substance as just read to you?

Answer. No.

161. Question. Have you any reason to question the accuracy of such testimony?

Answer. No. In all of these questions that you are reading to me, I am assuming that they are direct quotations, and that being so, the testimony was given.

162. Question. Will you look at the diagram marked "Plaintiff's Diagram No. 2," appearing on page 2319 of the printed record of the De Forest case, and say if the Marconi company made, sold, and used apparatus like that depicted in this diagram?

Answer. I think that those were used in what was known as the "United Fruit contract."

163. Question. That is, used by the Marconi company? [fol. 972] Answer. It was a contract by which the Marconi company attempted to give certain radio service to the United Fruit Co.

Mr. Edwards. The diagram shown the witness is offered in evidence as defendants' Exhibit W-5.

By consent a photostat copy of the diagram will be substituted for the original and marked in evidence by the commissioner.

164. Question. Can you state to what extent apparatus of this type depicted in this diagram No. 2 was made or used by the Marconi company during your connection with that company?

Answer. If I remember correctly, the principal use was for the purpose previously named.

165. Question. Will you state more in detail what that purpose was?

Answer. For improving the receiving at the United Fruit stations.

166. Question. Can you recall about what time this apparatus was used in the United Fruit stations?

Answer. No.

167. Question. Can you give approximately the year?

Answer. No.

168. Question. What type of detector had previously been used in the United Fruit stations where this apparatus, like Diagram No. 2, was to be used?

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Answer. I can not answer that question definitely, other than to say that I believe practically every type then in use had been used but without very satisfactory results.

169. Question. In the printed record of the De Forest case I find, at page 169, in answer to question as to when the Marconi company commenced to use apparatus like No. 2, the following testimony:

"Answer. The type of apparatus shown in diagram No. 2 was put into service in 1914, about the middle of the year, as near as I can place it, and the initial set installed at the United Fruit Co. station at New Orleans, etc."

Have you any reason to doubt the accuracy of that testimony?

Answer. No.

170. Question. Did the Marconi company ever use the carborundum crystal detector in its service while you were connected with that company?

Answer. It fell heir to the United Wireless receivers which had been using carborundum; that was the principal use, I would say.

171. Question. Had the Marconi company used the carborundum crystal detectors before that?

Answer. It is probable they were used on these same United Fruit stations.

172. Question. How long did the use of the crystal detectors by the Marconi company continue, so far as you can recall?

Answer. I can not recall.

173. Question. I quote the following testimony, at page 171 of the printed record of the De Forest case:

"24. Question. Did the Marconi company ever use the carborundum crystal detector in its service, and if so when?

"Answer. The Marconi company used the carborundum detector, yes; from about 1908 up until the present day."

Does that testimony accord with your present recollection? [fol. 973] Answer. I had not thought that that use was quite so early as that. It may be that the experiments that the London company had made in England, and which they called the balanced crystal receiver may have been in my mind when I made that answer you have just quoted.

174. Question. According to the printed record the testimony quoted appears to have been given in November, 1915. Have you any reason to doubt the accuracy of this testimony?

Answer. No.

175. Question. I also find in the record referred to, on page 172, immediately following certain statements by the court and counsel with reference to the line of examination in question 24, the following:

By the court:

"25. Question. From 1908 until when, Mr. Sammis?

"Answer. Until 1915."

Have you any reason to doubt the accuracy of this date as to how long the use of the carborundum detector continued by the Marconi company?

Answer. No.

176. Question. What was the relative sensitiveness and efficiency of the detecting organization shown in diagram No. 1 of defendant's Exhibit V-5 and the carborundum crystal apparatus?

Answer. Which carborundum crystal detector apparatus?

177. Question. I am referring to the carborundum crystal detector which you testified the Marconi company had used.

Answer. That had been used in a variety of circuits, I would say, and it would be very difficult to make a particular comparison such as you ask me to make now without more detail information about circuits and other conditions.

178. Question. At page 172 of the printed record in the De Forest case I find the following testimony:

"26. Question. Please compare that detecting organization of the diagram No. 1 of the stipulation, Exhibit R, and the carborundum crystal detector, both as used by the Marconi company, in respect of relative sensitiveness and efficiency?

"Answer. From my experience with it I should say it could be very roughly estimated to be at least 100 per cent more efficient.

"27. Question. Which is a 100 per cent more efficient?

"Answer. This type.

"28. Question. Diagram No. 1?

"Answer. Yes, sir; than the carborundum. That, of course, is an average taken from large and small, and short distances and long distances."

Have you any reason to doubt the accuracy of the testimony given by you in 1915?

Answer: No; I have not the least bit of recollection, though, of what type of circuit the carborundum was used in to which I had reference at that time.

179. Question. What type of carborundum crystal detector did you have in mind in giving this testimony?

Answer. I believe that I must have had in mind a type that has been developed in England in which two or three crystals were balanced as to their characteristics. Such receiver had been used in Brazil, or it was proposed to use such a receiver there, its principal advantage being its ability to nullify static.

180. Question. Then the testimony referred to did not refer to a comparison between the organization of diagram No. 1 and the ordinary crystal detector arrangement? Is that substantially correct?

Answer. It might have. What I was trying to say there was that the vacuum-tube detector itself, somewhat regardless of its exact circuit, was a more sensitive organism.

(Direct examination closed.)

(Cross-examination waived.)

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Mr. Edwards: Defendants' counsel offers in evidence the following:

File wrapper and contents of United States patent to Marconi, No. 763772 granted June 24, 1904, marked "Defendants' Exhibit X-5."

British patent to Marconi, No. 12039 of 1896, marked "Defendants' Exhibit Y-5."

File wrappers and contents of reissue patent No. 11913, granted to Marconi June 4, 1901, marked "Defendants' Exhibit Z-5."

File wrapper and contents of United States patent to Marconi No. 586193, granted July 13, 1897, marked "Defendants' Exhibit A-6."

United States patent to Marconi No. 627650, granted June 27, 1899 marked "Defendants' Exhibit B-6."

United States patent to Marconi No. 647007, granted April 10, 1900, marked "Defendants' Exhibit C-6."

United States patent to Marconi No. 647008, granted April 10, 1900, marked "Defendants' Exhibit D-6."

United States patent to Marconi No. 647009, granted April 10, 1900, marked "Defendants' Exhibit E-6."

United States patent to Marconi No. 668315, granted February 19, 1901, marked "Defendants' Exhibit F-6."

Manual of Wireless Telegraphy, by Robinson, 1911, pages 95 and 122, marked "Defendants' Exhibit G-6."

Wireless Telegraphy, by Zenneck, published in 1915, pages 84 to 86, inclusive, marked "Defendants' Exhibit H-6."

Wireless Telegraphy, by Leggett, 1921, pages 10 and 11 and 60-63, inclusive, marked "Defendants' Exhibit I-6."

Transactions of the New York Electrical Society for April 17, 1912, pages 4-29, inclusive, marked "Defendants' Exhibit J-6."

Pages 1 to 26, inclusive, of a pamphlet entitled "Marconi Wireless Telegraph Co., Ltd.," being a reprint of a lecture delivered by Mr. Marconi at the Royal Academy of Science, Stockholm, December 11, 1909, marked "Defendants' Exhibit K-6."

United States patent to Tesla, No. 649621, granted May 15, 1900, marked "Defendants' Exhibit L-6."

United States patent to Braun, No. 797169, granted August 15, 1905, marked "Defendants' Exhibit M-6."

United States patent to Braun, No. 797544, granted August 15, 1905, marked "Defendants' Exhibit N-6."

[fols. 975-976] Publications 115A, 115B, and 115C, forming Exhibit 115 shown witness Marconi on cross-examination at page 523 of the record, marked "Defendants' Exhibit O-6."

(The examination by counsel being concluded the witness, in compliance with the regulations of the court requiring him to state whether he knows of any other matter relative to the claim in question, says that he does not.)

(Deposition closed.)

(Defendant rests.)

[fol. 977] CLAIMANT'S EVIDENCE IN REBUTTAL

Proofs in behalf of claimant in rebuttal, taken commencing on Tuesday, October 6th, 1925.

Appearances:

James J. Cosgrove, Esq., Counsel in behalf of Claimant.
Clifton V. Edwards, Esq., Special Assistant to the At-

torney-General of the United States, Counsel in behalf of the Defendant.

Mr. Cosgrove reads in evidence the following stipulation entered into by counsel for the respective parties:

"It Is Hereby Stipulated that the annexed copy of the testimony of William J. Kinsley, David Sarnoff, John Bottomley, John W. Griggs, Albert Ginman, and C. H. Taylor, respectively, is a true copy of the testimony given by said persons respectively between the 9th day of March, 1916, and the 19th day of April, 1916, on behalf of the plaintiff in the suit in the United States District Court for the Western District of Washington, Northern Division, brought by the claimant herein against the Kilbourne & Clark Manufacturing Company, as defendant, for infringement of the Letters Patent in suit herein to Lodge No. 609,154 and Marconi No. 763,772; that said William J. Kinsley, David Sarnoff, John Bottomley, John W. Griggs, Albert Ginman and C. H. Taylor, if called as witnesses herein and duly sworn, would each repeat his said testimony, and that said testimony be and hereby is made a part of the evidence on behalf of the claimant herein, with as full force and effect as if each of said persons had been duly called, sworn and testified herein.

"It Is Also Stipulated that the annexed copies of exhibits are true copies of exhibits offered in evidence in said suit in connection with the said testimony of William J. Kinsley, David Sarnoff, John Bottomley, John W. Griggs, Albert Ginman and C. H. Taylor, and that said copies be and hereby [fol. 978] are made a part of the evidence herein on behalf of the claimant with the same force and effect as if the originals of said exhibits had been duly offered and received in evidence herein, and that said copies of said exhibits are hereby marked in evidence herein as claimant's exhibits as follows:

Number

- 150 Kinsley Photographs—Stone-Baker Letters 1, 2, 3 and 4. (Pl. Ex. 38H and 1, 2, 3 and 4, Kilbourne & Clark case.)
- 151 Drawing Marconi Early Tuned Transmitters and Receivers. (Pl. Ex. 39-I, Kilbourne & Clark case.)
- 152 Catalogue Marconi-Franklin Tuner. (P. Ex. 39-J, Kilbourne & Clark case.)

- 153 Photograph Marconi Tune A and B Apparatus. (P. Ex. 39-K, Kilbourne & Clark case.)
- 154 Diagram of Seneca Apparatus. (P. Ex. 39-L, Kilbourne & Clark case.)
- 155 Marconi Circular No. 37 in re Operation of Stations. (P. Ex. 39-M, Kilbourne & Clark case.)
- 156 Marconi Shipping Orders for Marconi Tuned Apparatus. (P. Ex. 39-N, Kilbourne & Clark case.)
- 157 Marconi Tune A Transmitters. (P. Ex. 27-T-1-Kilbourne & Clark case.)
- 158 Marconi Tune A Receiver. (P. Ex. 27-T-2-Kilbourne & Clark case.)
- 159 Marconi Tune B Transmitter. (P. Ex. 27-T-3-Kilbourne & Clark case.)
- 160 Marconi Tune B Receiver. (P. Ex. 27-T-4-Kilbourne & Clark case.)
- 161 Marconi Tune B Motor Set. (P. Ex. 27-T-5—Kilbourne & Clark case.)
- 162 Marconi Early Tuned Magnetic Detector. (P. Ex. 27-T-6—Kilbourne & Clark case.)
- 163 Marconi Multiple Tuner Magnetic Detector. (P. Ex. 27-T-7—Kilbourne & Clark case.)
- 164 Marconi Tuned Receiver—Variable Condenser. (P. Ex. 27-T-8—Kilbourne & Clark case.)
- 165 Marconi Untuned Plain Aerial. (P. Ex. 27-T-9—Kilbourne & Clark case.)
- 166 Marconi Multiple Tuner—Magnetic Detector. (P. Ex. 27-T-10—Kilbourne & Clark case.)
- 167 Marconi Shipping Orders for Tune B. (P. Ex. No. 28—Kilbourne & Clark case.)
- 168 Marconi Instructions for Tuned Apparatus. (P. Ex. No. 29—Kilbourne & Clark case.)

“It Is Further Stipulated that the objections entered and stipulations made by counsel during the taking of said testimony of William J. Kinsley, David Sarnoff, John Bottomley, John W. Griggs, Albert Ginman and C. H. Taylor in said suit shall be taken as though made as a part of the proceedings herein.

“Defendant makes the foregoing stipulation solely to avoid the expense and inconvenience of retaking said de-[fol. 979] positions, and it is stipulated that defendant shall not, by reason of making said stipulation, be deemed to

have admitted the truth of any of the matters testified to by said witnesses."

Mr. Cosgrove: Claimant's counsel offers in evidence the original of the stipulation referred to as "Claimant's Exhibit 169, Stipulation as to Testimony and Exhibits in Kilbourne & Clark Suit."

Mr. Cosgrove: Claimant's counsel reads in evidence the testimony referred to in the stipulation, which testimony is as follows:

Brooklyn, N. Y., March 10, 1916.

Proofs for final hearing taken on behalf of plaintiff at the office of the Clerk of the United States District Court for the Eastern District of New York, in the Post Office Building, Borough of Brooklyn, New York City, before Percy G. B. Gilkes, Esq., Standing Examiner in the United States District Court, Eastern District of New York (acting as Examiner by agreement of parties in the place and stead of Thomas B. Hardin, Esq., named in said order) pursuant to an order herein dated March 3, 1916, and to notice to defendant's counsel thereunder, beginning March 10, 1916, at 10:30 A. M.

Deposition of William J. Kinsley, for Claimant, taken at Brooklyn, N. Y., on the 10th day of March, A. D. 1916

Claimant's Counsel, John W. Peters, Esq., Defendant's Counsel, George F. Scull, Esq.

Direct examination.

By Mr. Peters:

Q. 1. Please state your name, age, residence and occupation.

A. William J. Kinsley; age, 50; residence, Nutley, N. J.; office, 261 Broadway, New York City; examiner and photographer of questioned documents, handwriting, typewriting, ink and paper.

Q. 2. Please state your training and experience, if any, which qualifies you as an expert examiner and photographer of questioned handwriting, typewriting, etc.

A. I took two special courses of penmanship, one in Providence, R. I., Bryant & Strattan Business College, the other under H. W. Flickinger, of Philadelphia, taking nor-

mal penmanship work under Mr. Flickinger; and for thirty-one years have been a professional penman; about twenty-nine years of that time I have given particular attention and study to questions involved in disputed documents, and for twenty-one years have been testifying in courts of law in questioned document cases. For several years I was associated with Daniel T. Ames, founder and editor of the *Penman's Art Journal*, and expert in handwriting, and succeeded to his practice. I studied under Mr. Ames; also wrote several chapters for his book, "*Ames on Forgeries*." I edited the *Penman's Art Journal* for seven years, a periodical devoted to penmanship in all its branches and of international circulation. I have written for that magazine and others quite a number of articles on handwriting, identification of handwriting and so on, and also have lectured some on the subject. I have had 1630 cases in 31 states of the United States and 2 provinces in Canada, and [fol. 980] have testified in several hundred of those cases, amongst these cases were 29 murder cases. In the examination and photography of documents I have done work and am still doing it for the United States District Attorneys of the Southern District of New York, Eastern District of New York, and several other districts in these and surrounding states, covering quite a number of states. I have also done work for the District Attorneys and State's Attorneys and Attorneys General in a number of states of the United States in cases extending from Maine to California and from Canada to Florida and New Orleans.

Q. 3. I show you what purport to be three letters, one dated June 30th, 1899, addressed "My dear Baker" and signed "John Stone Stone," one dated July 18, 1899, addressed "My dear Baker" and signed "John Stone Stone," and a third dated Boston, July 22, 1899, and signed "Joseph B. Baker," all enclosed in a binder marked "Marconi Wireless Telegraph Co. of America *vs.* Atlantic Communication Co. et al., Defendant's Exhibit F-1," forming a part of the records of the Clerk of the United States District Court for the Eastern District of New York. I also show you photolithographic copies of these three letters offered in evidence in the present suit (*Marconi v. Kilbourne-Clark*), and marked Defendant's Exhibits 1, 2 and 3 respectively,* and

* Marked in *Marconi vs. U. S.* as Defendant's Exhibits E³, F³ and G³.

I ask you, if you have not already done so, to make a careful examination of the alleged original letters, paying particular attention to the date June 30th, 1899 on one letter and the correction June 20 in the letter of July 22, 1899, also to the signatures of the letters.

A. I have already made such an examination, making it for the first time May 15, 1915, and have examined the same papers on several occasions since that time. I made a careful inspection of the handwriting in the body, the date, the signature and the corrected date, June 20, in the letter of July 22, 1899, the letter signed Joseph B. Baker.

Q. 4. In your opinion, was the date, June 30th, 1899, on the first of the letters called to your attention written at the same time and under the same conditions as the body of the letter of which it forms a part?

A. In my opinion, it was not.

Q. 5. Please explain fully on what you base your opinion.

A. On three things: first, the ink; second, the pen; and third, the handwriting itself. The ink, in my opinion, in the date June 30th, 1899, is decidedly bluer than the ink in any other part of the handwriting in the letter. This ink, while it has been blotted and this would make it somewhat lighter in appearance than if it had not been blotted, yet, nevertheless, the blotting, in my opinion, cannot account for the extremely light shade and the rather brilliant blue appearance for an ink of this character, supposedly on the paper for nearly seventeen years now; and we have the comparison between the ink in this date with the ink in other parts on the several pages of this letter, so we know how the ink, if put on at the same time under the same conditions, should now appear. The ink in the body of the letter has in nearly the entire letter the greater part of the blue that was in the ink originally now covered by the darkening of age and by an iridescent sheen on the ink. In the ink in the date, June 30th, 1899, it is distinctly blue, and even the edges of the strokes have no indication of this [fol. 981] iridescent sheen. This iridescent sheen is the result of the aging of ink of this kind and base. In other parts of the document, the letter which consists of four pages, blotting paper has been applied, and even where the writing has been blotted and a large part of the coloring matter of the ink removed, this blotted writing does not compare with the ink tint in the date of June 30th, 1899. The divergence between the shade of the ink in this date,

June 30th, 1899, and the balance of the writing on the four pages of the letter is so marked as to, I think, quite clearly show that the ink in the date June 30th, 1899 has been on the paper much less time than the ink used in the body of the document.

My second reason for arriving at the conclusion that the date was not written at the same time and under the same conditions as the body writing is that the pen, in my opinion, used to write this date was a different pen from that used in writing the balance of the letter. This shows in the pen strokes, especially when magnified, shows in the line quality, and particularly on the light, or what should be light strokes.

The third reason for arriving at the conclusion that the June 30th, 1899, is a later writing than the body of the letter, than the balance of the writing in the letter, is the handwriting itself. It does not appear to be a continuous operation. There is a break in the continuity of the writing. It lacks the connection between the June 30th, 1899, and the balance of the page that we find between the "My dear Baker" in the salutation and the balance of the page. In other words, the "My dear Baker" appears to be written with the same ink, the same pen, and the handwriting seems to be continuous; that is, the "My dear Baker" and the writing following it appears to have been done at one and the same writing operation, not disconnected and no break in the continuity of the writing. The further fact that the date, June 30th, 1899, alone is blotted is a rather significant point, for the reason that in the ordinary course in writing it would not be blotted, and if a blotter was applied to the page it would be the part that had not dried, which would be the bottom part of the page. Instead of that, we find the first line blotted and the second line not blotted, and several lines down the page are unblotted; in fact, I don't see evidences of blotting paper having been applied on the page anywhere except on this date of June 30th, 1899.

These reasons, taken together, are my reasons for arriving at the conclusion that, in my opinion, the date, June 30th, 1899, was not written at the same time that the balance of that page was written, but was written at some subsequent time with another pen and another ink, and the handwriting of slightly different quality, but, in my opinion, in the same hand.

Q. 6. In your opinion, was the correction, "June 20th," in the body of the letter dated Boston, July 22, 1899, a copy of which the defendant has offered in evidence as Defendant's Exhibit No. 1 (present case as Deft.'s Ex. No. E³), made by the same person, with the same pen and the same ink and at the same sitting as the signature "Joseph B. Baker," forming a part of said letter?

A. In my opinion, it was not.

Q. 7. Please state your reasons for reaching this conclusion.

A. My reasons for stating that this date was not made with the same pen and ink and one continuous piece of writing at the same sitting with the signature "Joseph B. Baker" are that, first, the ink is distinctly divergent; it is another kind of ink; it is so distinctly different that I think that at even a casual inspection it shows to the naked eye [fol. 982] that two different inks were used; that is, I think inks with two different bases were used, one in the signature of Baker, the other in the June 20 alteration and the line going through the typewritten "20th" below. The ink in the correction, June 20, is a different type of blue and lacks the microscopic marginal definition which is found in the Joseph B. Baker signature. In the Baker signature the margins of the pen strokes are well defined by a black outline, and this is entirely lacking from the June 20 and the line drawn through the "20th" typewritten just below. I don't think that there can be any question but what these inks are entirely separate and distinct types of ink, and, in any event, their colors are very different.

The second reason for arriving at that conclusion that the June 20 was not written at the same time as the Joseph B. Baker signature is the matter of pen. The pen stroke and line quality in the words "June 20" are so distinctly different from the pen stroke in the Baker signature as to be apparent at a glance. The pen used in making the alteration in the date, in writing the June 20, was a coarser pen, made a heavier mark on the upstroke, and has the sort of a line quality that indicates it was a fine stub pen and not the kind of pen used by Baker in writing his name. The June 20, corrected date, has had blotting paper applied to it, and, notwithstanding that, the ink is darker in appearance than the Joseph B. Baker signature, which did not have blotting paper applied to it. I also am inclined to think that the handwriting differs quite decidedly in the

June 20 from the handwriting of Joseph B. Baker. I have not any June 20 standard of Baker's handwriting with which to compare its questioned writing in the date, but the handwriting June 20, correction, appears so different in line quality from the Joseph B. Baker signature as to cause me to think that these divergences could not all have been accounted for by change of pen and change of ink.

* * * * * * *

A comparison of the strokes in the June 20 alteration on this letter of July 22, 1899, Joseph B. Baker letter, with the pen strokes in the date "June 30th, 1899," the letter to Baker signed "John Stone Stone," shows a very close resemblance between them; in fact, the June 30th, 1899 in the one letter and the correction of June 20 in the other letter are nearer alike in line quality than are the June 30th, 1899, and the body writing of that letter, or the June 20 on the Baker letter and the Baker signature. In other words, the nearest match, so far as pen is concerned, is between the two dates, June 30th, 1899 in the one letter and June 20 in the other letter. Another thing that is significant and serves to connect these two letters in my opinion is the ink in these two dates. The June 30th, 1899 date and the corrected date of June 20 in the Baker letter are very close together in color. They are closer than any other combination that can be made in these two letters. In other words, the two dates appear to match in line quality so far as pen is concerned and, in my opinion, do match very closely, and they also match in shade in ink, and in these [fol. 983] agreements they diverge from the other pen and ink writings on their respective letters with which, supposedly, they should agree. There is also in handwriting in this June 20 correction in the Baker letter some resemblance to the handwriting in the June 30th, 1899 date.

Q. 8. Please briefly compare the correction June 20 as to handwriting, pen and ink, with the writing forming a part of the letter dated July 18, 1899, and state any conclusions which you reach.

A. I have already compared that. In my opinion it does not compare so far as ink is concerned; the ink is at present not in the same condition in two papers, and, in my opinion, the ink in the June 20 has not been on the paper so long as the ink in the July 18, 1899. The July 18, 1899 ink has much more body to it, decidedly bronzed iridescent sheen,

which is entirely lacking from the June 20 corrected date. As to handwriting I can hardly say. It is the same type of pen used by the writer of the letters of July 18, 1899, and the June 30th, 1899; the handwriting has some resemblance to that handwriting, more resemblance, in my opinion, than it has to the Joseph B. Baker handwriting.

Q. 9. Have you made photographic copies of the three alleged original letters which you have referred to above?

A. Yes.

Q. 10. Will you please produce the same and state when and under what conditions made, and what, in your opinion, the photographs show?

A. I made the photographs eight or ten months ago in this office, and I am producing a photographic album (Claimant's Ex. No. 150), which, on page 1, contains a natural size correct photographic reproduction of the first page of the June 30th, 1899, letter. Page 2 of the album is a natural size correct photographic reproduction of page 2 of that same letter. Page 3 of the photographic album is a natural size reproduction of the letter of July 22, 1899, signed Joseph B. Baker. Page 4 of the album is a comparison of the corrected date, June 20, on the Baker letter of July 22, 1899, with the portion of the date, June 30th, on the other letter, and also a portion of the first line in the body of the June 30th, 1899, letter showing the words "chief limitation to the". These were photographed at one and the same operation and enlarged five diameters or twenty-five times. The object of these photographs, and especially in the one on page 4 showing the enlargement, was to get on the same photographic plate at one and the same exposure and one handling throughout, three comparisons; one at the top being the June 20 corrected date on the letter signed Baker; the next line being the June 30th date on the letter signed Stone; and the third line, the one at the bottom of the page, being the first line in the body of the letter proper, in the Stone letter of June 30th, 1899. This gives us an opportunity of comparing handwriting, pen and ink, so that we thus have the result of magnification and the opportunity to compare color values which are correctly represented in the three lines of writing. The comparison of the June 30th with the first line in the body of the letter shows distinctly divergent color values which cannot, in my opinion, be wholly accounted for by the fact that blotting paper was applied to

the June 30th and not applied to the words "chief limitation to the", and also to compare the width of the pen strokes and the quality of the handwriting itself. The quality of handwriting in the June 30th shows, in my opinion, that it was not done at the same sitting with the writer in the same position as was the writing in the body of the [fol. 984] letter. The width of pen strokes and the general quality of line made by the up and down strokes in the June 30th diverges distinctly from the writing in the body of the letter, although I think the same style of stub pen was used in both writings. Then, when we compare the June 20 alteration, which is the first line in this enlarged photograph, with the other lines, we find the June 20 more nearly approximates the June 30th line in line quality and in shade of ink. The same type of pen was used in writing June 20 that was used in writing June 30th, that is, a narrow pointed stub pen. This photograph, in my opinion, reinforces the conclusion arrived at from an inspection with the naked eye and with low power glasses and with ink comparison microscope. I examined all of these writings with an ink comparison microscope, which has two objectives and one eye piece. I placed one objective on one document and the other objective on the other document; for example, the June 20 and the June 30th were inspected at one and the same time; and I also compared the June 30th with other parts of the writing in the same letter. In my opinion, the photograph reinforces the conclusion arrived at from the microscopical examination that there is a distinct divergence between June 30th and the body writing, and a rather close resemblance between June 30th and June 20, and this applies to ink and to pen. I would say in regard to these photographs that a scale was put on and photographed with the object each time. On pages 1, 2 and 3 the scale comes out three inches, showing that the pages were photographed natural size. On page 4 the scale is enlarged five diameters plus, or twenty-five times. The objects were enlarged, of course, with the scale at one and the same operation.

Mr. Peters: I offer in evidence the album referred to by the witness, containing four photographs of the Stone-Baker letters, and the same is marked Plaintiff's Exhibit H-1, 2, 3 and 4, Kinsley Photographs, Stone-Baker Letters (Claimant's Ex. No. 150).

Q. 11. Please now refer to the copies of these three letters marked in the present case (*Marconi v. Kilbourne-Clark*) as Defendant's Exhibits 1, 2, and 3,* and state if you are familiar with the process of copying by which they were made, and if such process is adapted to show details and irregularities in writings such as those to which you have referred.

A. I am familiar with the process, for several years conducting a penmanship studio, where I had photo-lithography done, and we made thousands of diplomas by this identical process, and in my opinion such reproductions only show the outlines and do not represent correctly the color values and the differences existing in, for example, the June 30th, 1899, date and the balance of the writing on that page. The method by which photo-lithography works is to make what is known as a "contrasty" photographic negative first, and by that process it makes the light parts of a document, light in shade or tint, just as black, or they aim to make them just as black, as they do the very blackest part, in order to have a contrast between the lines and the surrounding white document. This kind of a negative then is transferred to the lithographic stone, and, of course, the June 30th and the June 20 writings are just as black when transferred to the stone as any other parts of their respective letters, and the Baker and the June 20 agree in blackness, [fol. 985] and the June 30th, 1899, is just as dark as the balance of that letter, and it is not a correct color value representation of the original exhibits, and I think the photographs that I have made will show that. These color values can be shown, and I have tried to show them, just as they existed in the originals, and that is noticeable in all four of the photographs, and especially so in the photograph No. 4 of Exhibit II. There are three gradations in the three lines; the bottom line, the words "chief limitation to the" is practically a dead black; the June 20 at the top is considerably lighter, the blue in the ink not taking black, while the June 30th date is even a little lighter than the June 20, just a trifle; and it shows these three gradations in color value in the three lines. The same relative gradations are shown in the natural size photographs as they appear on pages 1, 2 and 3. Now, in the other exhibits, Defendant's Exhibits 1, 2 and 3 (Present Case Defend-

* *Marconi v. U. S.*—Defendant's Exhibits E³, F³ and G³.

ant's Exhibits E³, F³, G³), there is not a particle of gradation between the June 30th, 1899, and the body writing so far as color is concerned. The same can be said of the June 20 alteration. It is just as black and just as light as the Joseph B. Baker; and, in fact, while, in my opinion, three different inks were used and three different pens were used in writing the date and the bodies of the letters of June 30th, 1899, and July 22, 1899, so far as ink is concerned in these Defendant's Exhibits 1, 2 and 3 all appear to have been done with one and the same ink, and that is due to the process of reproducing the original letters.

Cross-examination.

By Mr. Scull:

X Q. 12. When were you retained in this case?

A. About the middle of May, 1915.

X Q. 13. At that time had you seen the originals of Defendant's Exhibits 1, 2 and 3 (Present Case Defendant's Exhibits E³, F³, G³)?

A. That is the time that I saw them, at that time, at one and the same operation. I was engaged to look at them and examine them. I saw them for the first time on May 15, 1915.

X Q. 14. What comparisons were you asked to make at that time?

A. To determine, if possible, whether or not all of the handwriting on the letter of June 30th, 1899, was put on there at one and the same time, and also when it was put on.

X Q. 15. Anything else?

A. I don't recall that I was asked in regard to the Baker letter, the June 20, although I may have been asked about that.

X Q. 16. Were you asked in reference to the Stone letter of July 18?

A. I forget whether or not I was asked about that at that time or any time; I don't recall now.

X Q. 17. Have you studied the original letter of July 18, 1899?

A. Yes.

X Q. 18. In the same way in which you have studied the other exhibits?

A. Yes.

X Q. 19. Have you compared the date, July 18, 1899, with the body of that letter?

A. Yes.

X Q. 20. Is it your opinion that that date was written at the same time as the body of that letter?

A. I was unable to determine. The ink has the same sheen, substantially, as the body and has been on the [fol. 986] paper a long time. The handwriting differs in slant a little from the balance of the writing on the page.

X Q. 21. If the ink has the same sheen, is it not evidence that the ink in the date line and in the body of the letter have been on the paper the same length of time?

A. Yes; it indicates that at least they have both been on so long, if they are the same kind of ink, that it is now difficult to differentiate between them.

X Q. 22. Do you see any reason to believe that that date line was not put on at the same time the body of the letter was written?

A. No; nothing except a little difference in the handwriting; and that was not sufficient to lead me to say it was not done at the same time.

X Q. 23. I understand that you are of the opinion that the correction, June 20, in the Baker letter of July 22, 1899, has not been on that paper as long as the ink of the signature to that letter. Is my understanding of your position correct?

A. No, I did not say that. I said it was not the same kind of ink as the signature and not written with the same pen as the signature; I don't know how long either of them have been on the paper.

X Q. 24. Then, you cannot tell, as I understand, the relative length of time which the correction, June 20, and the signature have been on this Baker letter of July 22, 1899?

A. No; the Baker signature appears to be written with an ink that does not show age at all; whereas the date is written with an ink that does and will show age progressively; but the difference between the times when they were put on I have no means of determining just by comparing those two writings themselves.

X Q. 25. Have you examined the date line, "Boston, July 22, 1899," in the typewritten letter of Joseph B. Baker of that date?

A. I just glanced at it; I did not attempt to run down the typewriting.

X Q. 26. Were you not asked to examine that date line particularly?

A. I think not; I have just glanced at it.

X Q. 27. Do you have any recollection of having been asked to examine that date line particularly?

A. I have no recollection; I think I was not asked.

X Q. 28. Now, please examine that date line and see whether or not there is any evidence of erasure or change in it so far as you can see.

A. There is none.

X Q. 29. What is the characteristic color of the ink in the signature, "Joseph B. Baker", on the July 22, 1899 letter?

A. It is a bluish gray center, with a microscopic edge or marginal line that is a little blacker; it has a slight purple in the blue there as well.

X Q. 30. And I think you have said that that signature show evidences of having been blotted.

A. No; I said it did not show any evidences of having been blotted; the June 20, I said, I thought had been blotted.

X Q. 31. Well, what would account for the fact that the centers of the strokes in the "Joseph B. Baker" are lighter in shade than the edges, if the same has not been blotied?

A. That is caused by the character of the ink used. I am inclined to think it is a nigrosin ink, or, at least, has nigrosin in it. Nigrosin is a coal tar by-product, and produces an ink which gives that microscopic margin to which I have referred and which is entirely missing from the June 20 writing, which, I think, is an iron ink writing, iron nut-gall writing fluid. This microscopic margin clearly shows in the Joseph B. Baker signature that blotting paper [fol. 987] was not applied, and it is characteristic of a nigrosin ink to produce a marginal definition with the interior part of the stroke lighter.

X Q. 32. Do I understand that you have testified that you found evidences which cause you to have the opinion that the date, June 20, on Defendant's Exhibit 1 (present case F³), was written by the same hand which wrote the date, June 30th, on Defendant's Exhibit 2 (present case F³), or the originals thereof, rather?

A. Yes; there is some evidence. I am not strongly of the opinion that it was one and the same hand, because there is not enough writing there for comparison; there is some little indication.

X Q. 33. What is that little indication?

A. Its general pen movement. The same general slant of the writing, particularly in the small letters "u" and "m". There is the safe difference in proportions between the "2" and the cipher in the "June 20" and the "3" and the cipher in the "30", and also divergence in slant, the "2" being a little backhand, the cipher forward slant; the "3" being backhand and the cipher being nearly vertical. In line quality there are a number of resemblances, the movement used to produce the writing there are a number of resemblances, in pen pressure resemblances are quite marked. But that is as far as I can go.

X Q. 34. According to your art, do you say that the cipher in the "20" and in the "30", respectively, have the same slant, or approximately the same?

A. No, not the same or approximately the same. The one in the "20" slants distinctly, decidedly to the right of vertical; the one in the "30" is substantially vertical; it is kind of blurred and a little hard to get the slant of it, but they are not the same slant. However there is substantially the same divergence in slant between the "2" and the cipher and the "3" and the cipher. In the one case the "2" does not slant as much to the left of vertical as does the "3" in the other case; the cipher of the "20" slants decidedly more than the cipher of the "30".

X Q. 35. You say this does not slant as much——

A. (Interrupting): To the left of the vertical as does the "3".

X Q. 36. Now, please compare the characteristic formation of the figure 2 in the June 20 and the figure 3 in the June 30th, and tell me whether, in your opinion, those two letters belong to the same sets of numerals that one hand would ordinarily write?

A. I don't believe I could make a comparison of that kind, for the reason that I have to have a standard, and I would have to have a standard 2 which I do not have. You can't compare a 2 with a 3 for design or outline; all you could do would be to compare line quality, movement and speed of general writing, but not the outline itself. I don't know what outline the writer of the "30" would make for a 2.

X Q. 37. On the eighth page of the original of Defendant's Exhibit 3 (present case G²), I call your attention to the phrase, "June 30 ultimo" and ask you whether in your opinion that date was written at the same time and by the

same hand as the body of the letter, and particularly at the same time and by the same hand as the date, July 18, appearing at the top of sheet 1 of that letter?

A. In my opinion it is written with the same pen, the same ink, and in the same handwriting as the body, the balance of the letter, and by the person who write this letter. It appears to be the same time also, a continuous operation, so far as I can determine.

X Q. 38. And I asked you about the date.

[fol. 988] A. The ink appears to be the same condition, it is in the same handwriting, but whether or not done at that same time,—I have just a little doubt in regard to the July 18, 1899 date originally, but not enough to express any opinion on it. It appears to be written at one and the same operation, including the July 18th date. The handwriting is slightly different in the July 18 date from what follows; there is a slight difference in the slant.

X Q. 39. On the letter of June 30th, 1899, do you find any evidence of any erasure on the first page, and particularly at or about the place where the date June 30th, 1899 now appears?

A. No.

X Q. 40. In other words, you find no evidence that any other date has been on the paper than the one that now appears?

A. No; none whatever.

X Q. 41. Do I understand it to be your opinion that the date line, June 30th, 1899, has not been on the original of Defendant's Exhibit 2 (Present Case H³), for as long a time as the ink of the body of that letter?

A. Yes; that is my opinion.

X Q. 42. Can you give any idea of the relative times or period which these two inks have been on this paper?

A. No. I cannot; it is done by comparison. We have several pages of writing supposedly done at the same time as the paper is dated, June 30th, 1899, and I have a chance to compare that ink with the June 30th ink in the date, and the June 30th ink has not matured to the same extent as the ink in the body has matured; and the June 20, corrected date, in the Baker letter, matching so closely as it does the June 30th ink in the Stone letter, of course that would be the only way I could say that the Baker letter was probably not written at the same time as the date; not from a comparison by itself, but by a comparison of that

ink with the June 30th ink, and then a comparison of the June 30th ink with the body writing in that letter and also in the July 18, 1899 ink.

X Q. 43. In your opinion, the date line, June 30th, 1899, is written with a different kind of ink from that used in the body of the letter, is it not?

A. No; I am inclined to think it is much the same kind of ink, the same base of ink.

X Q. 44. Did you not find a different color value in the date line, June 30th, and the body of the letter?

A. Yes.

X Q. 45. Would that not indicate, then, that a different ink was used?

— . It might and it might not. It might be the same ink and the difference in color be due to the difference in age, the body writing having been on the paper longer than the date.

X Q. 46. Well, from your experience, can you approximate the relative times that the inks in the date line and in the body respectively of the June 30th, 1899 letter have been on that paper, assuming first that the body of the letter was written in 1899?

A. No, I don't believe I can even say approximately. I think that considerable time elapsed between the body writing and the writing of the date, but I don't know how many years.

X Q. 47. When you say a considerable time, what have you in mind?

A. Oh, five to ten years would be as near an approximation as I could give.

X Q. 48. Such difference as appears, could not, then, in your opinion, be produced by less than five years' difference in the times of writing?

A. That is only approximately; it is not at all definite. I don't do it by setting dates, but by comparison. There [fol. 989] is not any time clock on the development of ink after it gets that old, and I think the June 30th, 1899 ink has been on there long enough so that it is difficult now to determine definitely its age.

X Q. 49. And that is the nearest time, then, that you can approximate in this matter of the difference in the ages of these two inks?

A. Yes, that is as near as I could say.

X Q. 50. I think you said that the fact that the date line, June 30th, 1899 on the original of Defendant's Exhibit 2 (Present Case F³), was blotted, whereas the body of the letter was not blotted, that this difference was significant. In making this remark, did you have in mind the character of the contents of the body of that letter?

A. Yes.

X Q. 51. What do you understand that letter to be, so far as its contents are concerned?

A. A report on experimental investigation.

X Q. 52. Relating to wireless telegraphy, is it not?

A. Yes.

X Q. 53. Does the handwriting evidence care in writing it?

A. No.

X Q. 54. In your opinion, it was written hurriedly?

A. Yes.

X Q. 55. And without very much thought or pause on the part of the writer?

A. Yes.

X Q. 56. Did it occur to you in considering the contents of the letter that it was not at all impossible that the body of the letter was written first and the letter thereafter dated, immediately following its writing?

A. That did occur to me and that would be the only explanation for blotting if the ink was the same.

X Q. 57. Well, from your experience in examining questioned writings would that be an unusual situation in a letter of this character, consisting, as you believe, of a scientific report on wireless telegraphy?

A. Be an unusual condition to date it last?

X Q. 58. Yes.

A. I think it would be an unusual condition for anybody who wrote in this style, right off, without hesitation. The first thing I should think the average person would do would be to date it and then continue with it. Of course it would be unusual to go back and date it, although that could be done.

X Q. 59. Have you compared the character of the ink in the bodies of the two letters dated June 30th and July 18th respectively?

A. Yes.

X Q. 60. Is the ink on these two documents the same?

A. I think it is the same kind of ink.

X Q. 61. What is the evidence as to the comparative ages of the inks on these two documents?

A. The ink in the letter of July 18th, I think, has matured more, is blacker and has more nearly covered up the blue in it than has the ink on the letter of June 30th, 1899; there is a distinctly bluer cast in the body writing of the June 30th letter as compared with the July 18 letter.

X Q. 62. Then, in your opinion, the evidence is that the letter dated July 18, 1899, was written before the letter dated June 30th, 1899?

A. Either that, or else the ink, while the same kind was in a different condition when put on the paper. It might have been a fresh bottle in one case and in the other case from a bottle that had oxidized, right in the ink stand itself.

X Q. 63. What is your opinion as to the comparative ages of the writings in these two letters dated June 30th and July 18 respectively?

A. As far as I can judge from the ink itself, the June 30th has a fresher appearance than the ink of July 18. [fol. 990] There should not be any marked difference between June 30th and July 18 at this time, should not be any way by which you can tell them, supposing the ink was put on in the same condition. There must have been some difference in the conditions under which the ink was applied to the paper, although I believe it to be the same style of ink, the same base of ink on the two letters.

X Q. 64. Now, will you please state briefly which, in your opinion, of these two letters, so far as the body contents are concerned, was written first?

A. I can't say definitely, but the ink in the June 30th letter would indicate that it was written since the letter of July 18.

X Q. 65. Can you tell what the difference in the ages of these two letters is?

A. No.

X Q. 66. Can you even approximate it?

A. No.

X Q. 67. Would it be as much as a year?

A. I don't know.

X Q. 68. Would it be as much as six months?

A. I don't know.

X Q. 69. Would it be as much as a week?

A. I don't know. If the ink was in different—take the same bottle of ink, one exposed, and one bottled, might

produce variation as much as appears here, but if it is the same ink under the same conditions, some months or a year or two might have elapsed to produce this difference now, but I don't know the conditions.

X Q. 70. But you have said that in your opinion the letter dated June 30th was written subsequently to that of July 18, have you not?

A. Qualifiedly so; that the ink appears to be fresher than the ink of July 18.

X Q. 71. Then you have no opinion on the subject?

A. I have a qualified opinion on the subject; not a positive, definite opinion.

X Q. 72. And that opinion is based on the relative degree of freshness in appearance of these two inks?

A. Yes, the ink in the July 18 letter, the dark ingredients have more clearly clouded out the blue than has been the case in the June 30th letter.

X Q. 73. Now, I ask you, how long a period must elapse, in your opinion, before such a condition as that could arise?

A. I don't know, I don't believe anybody knows.

X Q. 74. You don't know whether one week would be sufficient for that?

A. No, I can't tell, because there are other conditions that we do not know anything about, whether it was a fresh bottle of ink or ink standing in an ink well exposed oxidized.

X Q. 75. In other words, then, if the difference in inks were such as you have just indicated, it might very well be that the letter of June 30th was, in fact, written before that of July 18th?

A. Yes.

X Q. 76. Did you find any difference in ink or general characteristics between the scratch marks through the figure "20th" and the correction date "June 20" on the Baker letter of July 22, 1899?

A. Yes, there is a slight difference, although, I think, it is the same ink. The difference comes in depth of color. In the crossing out mark more ink was put on the paper, the stroke was heavier, and the tint is a little deeper, although, I think, it is one and the same ink and applied under the same conditions.

X Q. 77. Was one blotted and the other not?

A. I think they were both blotted.

X Q. 78. Is not one considerably darker or heavier than the other?

A. Yes, one is. I am unable to tell, I think, definitely about the blotting of the stroke going through the type-[fol. 991] written figures; it may have been blotted and it may not; but there is no question but what the June 20 up above had a blotter applied to it.

X Q. 79. I show you an original letter marked "Defendant's Exhibit 7, A. G. Jr. Ex." (Present Case Deft's Ex. K⁴), and ask you to compare the signature on that letter with the original of Defendant's Exhibit 1 (Present Case E⁴), and tell me whether or not in your opinion, they are made by the same man?

A. I do not give off-hand opinions, as a rule, but they look very much alike.

X Q. 80. From the inspection which you have given them you have no reason to doubt they are signatures of the same hand?

A. No, they look very much the same.

X Q. 81. Will you please examine Defendant's Exhibit 7 (K³ in Present Case), and particularly the date line, "Boston, June 3, 1902," and also particularly the dates in the last two lines, June 30, 1899 and July 18, 1899, and tell me whether, in your opinion, there is any evidence in that document of those dates having been changed or altered?

A. I could not tell off-hand; I would have to—looking at that typewriting off-hand, I don't see any evidence of any alteration.

X Q. 82. Referring now to the letter dated June 30th, 1899, the original of Defendant's Exhibit 2 (F³ in Present Case), I call your attention to the fact that there are in a number of places thereon smears or color marks, apparently arising from the handling of the paper with a moist hand. Do you see the marks I refer to?

A. Yes.

X Q. 83. What is the color value of those marks, in tint, particularly?

A. It is blue, bluish.

X Q. 84. What is the comparison between the color of the blue from those blurs or smears and the blue in the date, June 30th, 1899?

A. That is much the same sort of tint. Of course, we have it massed in the June 30th and have it only smeared in the body.

X Q. 85. I call your attention to the photograph, Plaintiff's Exhibit H-4 (Claimant's Ex. 150), and ask you

whether the difference in the apparent color values between the date June 20 and the scratch through "20th" is not accentuated in that photograph as compared with the same color values in the original?

A. I think not; I think it is correctly represented.

X Q. 86. What is the general tint of the ink in that June 20 and the scratch?

A. Blue.

X Q. 87. And how does blue photograph in relative color values in a negative plate?

A. Somewhat light, unless a color correcting screen or filter is put on the lens and an orthochromatic plate is used to offset that, and that, of course, I did not do in this case, because I wanted to get the relative divergences in color.

X Q. 88. As I understand your last answer, different shades of blue produce different densities in the photographic plate and that such densities are not in the same ratio as the densities of the tints photographed, is that true?

A. I think it is not true; I think they are photographed in their exact ratio of density. The camera reproduces it more accurately than we see with the eye and differentiates as between these tints or shades of even the same color.

X Q. 89. Do I understand, then, that these photographic differences are differences brought out by the camera and are such as not evident to the eye?

A. No, in this case I think it is evident to the naked eye and it is certainly evidenced when they are examined even [fol. 992] under low power magnification that there are differences in the shade or depth of color in these writings.

X Q. 90. Did you not say that the camera brings out differences that are not apparent to the naked eye?

A. Yes.

X Q. 91. How did you suppress that particular function of the camera in this case?

A. I did not suppress it at all.

X Q. 92. Then, in this particular case the camera produced the same results as appear to the naked eye?

A. Substantially; that is, the eye, I think, can see everything that is shown here in all these photographs.

X Q. 93. You understand, Mr. Kinsley, my questions relate to a question of degree. What I am trying to ascertain is whether or not, in your opinion, a camera in photo-

graphing different shades of blue preserves the same relative values as are apparent to the eye, or does it accentuate them?

A. It does not preserve the same relative values if you use an ordinary plate. If you want to accentuate, if you want to reproduce those and show that the light lines are dark, of course, you have to use an orthochromatic plate and a ray filter. If you want to show the same relative conditions or to show the conditions as they appear in the camera, you use an ordinary plate.

X Q. 94. And in this particular case you used the ordinary plate and not the filter?

A. Yes, used the ordinary plate and not the ray filter.

X Q. 95. Then, again I ask you how do you account for the apparent statement that in this particular case the camera did something different from what it usually does, to wit, accentuate the difference in tints between two shades of blue?

A. Oh, the camera always accentuates the difference in degree between two shades of blue. For example, you have ink that is a deep blue and a light blue, and take the same identical ink, two dips, and put on twice as much ink on one stroke as on another, then if they are the same width of stroke one will appear darker than the other, because the camera and the photographic process that is used here reproduces only in white and black and not in colors; so we get the gradations of shade reproduced in white and black and we get color value.

X Q. 96. Is that color value in the same ratio as appears to the eye? I am asking this question generally now and not in reference to any specific exhibit.

A. Sometimes it is and sometimes it is not; it depends, of course, on the depth of the color. If you get a very light blue it would look bluer to the naked eye than it would photograph. If you get a darker blue, it might photograph about as dark as it looked to the eye.

X Q. 97. In other words, when you are shown a photograph of two specimens of writing, one of which appears dark and the other light, it does not necessarily mean to you that the originals had the same degree of difference in tints as appears by the photograph, is that correct?

A. That is true; it does not always show the same.

X Q. 98. I understand, Mr. Kinsley, that you have testified in a great many cases where questioned documents have been before the Courts?

A. Yes.

X Q. 99. And, as a matter of fact, that is your principal business, is it not?

A. That and the examination and photographing and preparation of it; not testifying. Of course, a small part of my time is spent in testifying, but the major portion of it in examination and preparation. Many cases are never tried at all and in many cases I do not testify as I decide against my clients.

[fol. 993] X Q. 100. In other words, you are a professional hand-writing expert?

A. Yes.

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 Redirect examination.

By Mr. Peters:

R. D. Q. 101. Will you state the exact date when the photographs. Plaintiff's Exhibit H-1, 2, 3 and 4 (Claimant's Exhibit No. 150), were made?

A. May 28, 1915.

R. D. Q. 102. The letter of June 30th, 1899, is marked evidently by the Examiner "Marconi v. Atlantic, Deft's. Ex. F1 (Present Case E³), May 14, 1915, J. L. O'Neill, Deputy Clerk." Was all of that marking on the letter when you made the photograph?

A. No.

R. D. Q. 103. Explain what part was.

A. That portion marked "Deft. Ex. F 1."

R. D. Q. 104. Please state whether or not the photographs that you have produced show substantially the same color values as the originals.

A. They do. A blue object, or blue ink, of course, has a tendency not to photograph black as it frequently appears, or dark, as it appears, to the human eye; but inks purporting to be put on with the same pen at the same time, the fairest way to show whether or not they were applied in the same condition, and if conditions now are the same, is to photograph them on the same plate, with exactly the same lighting conditions and the same magnification, as done on page 4 of this Exhibit H. The plate is absolutely un-

treated; it all had the same bath and it was handled the same way; the lighting was the same and it was exposed under the same conditions the three or four lines that appear on it, and it was developed at one and the same operation, fixed, washed and printed at the same time.

Recross-examination.

By Mr. Scull:

R. X Q. 105. What is the color in the original of the last line of Plaintiff's Exhibit H-4? (Part of Claimant's Exhibit No. 150.)

A. It is black substantially, when viewed with direct light; with transmitted light there is a slight blue tint showing in the interior parts of the stroke.

R. X Q. 106. Well, this photograph was taken with reflected light, was it not?

A. Yes.

R. X Q. 107. So that none of the blue that is in the interior of the strokes, as you say, would have any effect on this photographic plate?

A. No. Of course, had the photograph been made by transmitted light, the June 30th would be far lighter than it appears on the plate, Exhibit H-4.

R. X Q. 108. Now, how does black photograph?

A. It photographs black.

R. X Q. 109. Does it photograph practically true to tint?

A. Yes.

R. X Q. 110. But the blues don't photograph true to tint?

A. Blues don't with the ordinary plate and lens. Without a ray filter they have a tendency to come lighter, depending on the depth of color.

R. X Q. 111. And yet in the face of that statement and this you still say that Plaintiff's Exhibit H4 (Present Case G³) shows the correct relative color values of the different lines appearing thereon?

A. As they appear and the lines are recorded on the plate of the camera there is more blue in the June 20, and the line and the June 30th, of course, than appears in the last line [fol. 994] and consequently they appear lighter to the eye, and they appear, I think, even lighter in the prints than they do to the human eye; but they are all photographed at one and the same operation, and the effort was to reproduce them accurately as they appear.

R. X Q. 112. I am not asking what the effort was nor what the process it. You said on redirect examination that plate H4 shows substantially the color values of the original. Now, is that true?

A. It does, substantially.

R. X Q. 113. What does the word "substantially" mean in that case?

A. Well, they are nearly as dark as the originals by direct light; if it was a transmitted light photograph I think they would be much lighter.

R. X Q. 114. What do you mean by that?

A. All the writings. Well, the lines June 20, the cross mark, and the June 30th would appear much lighter than they do now; but substantially, notwithstanding they are blue, they do represent the color values; to the naked eye, of course, the June 30th has a decided blue tinge that it is impossible to reproduce in the photographs; that blue tinge asserts itself in the photograph by making the lines appear a little lighter, as far as black is concerned, than in the original.

R. X Q. 115. Have you examined the color value in the signature "John Stone Stone" to the letter dated June 30, 1899?

A. Yes.

R. X Q. 116. What is the color value of that as it appears to the naked eye?

A. It is a blue black.

R. X Q. 117. Does it not have a distinct blue appearance to the naked eye?

A. I would call it a blue black to the naked eye; when examined under magnification, you can see a little more blue in it.

R. X Q. 118. Does it have the same apparent tint to the eye as the body of the letter and particularly the page immediately above it?

A. No, it is slightly lighter, progressively so, beginning with the "J". The "J" is about as dark as the "Cordially", and from there on it is progressively lighter in tint, either because the ink gave out or a blotter was applied.

R. X Q. 119. Then, is it your idea that a blotter applied to the ink of the body of the letter of June 30th, 1899, would produce a bluish appearance?

A. It would be more blue than if no blotter had been applied, that is if the color was removed, a lot of it; then when

the ink dries it would be bluer than if the ink was allowed to dry undisturbed.

R. X Q. 120. How do you account for the progressively blue and bluer appearance of the signature 'John Stone Stone'? On either one of two grounds; that the ink was gradually giving out and it did not deposit so much ink there or that he did deposit the ink and blotted it and the last writing had more ink removed than the earlier part of the writing; that is, it was dryer in the first than the last part.

R. X Q. 121. That is to say, the more quickly the blotter were applied to the ink the bluer would be the appearance?

A. Yes.

Mr. Scull: Defendant's counsel now asks Plaintiff's counsel whether or not he concedes that the originals about which this witness has been testifying this morning, to wit, the letter dated June 30, 1899, July 18, 1899 and July 22, 1899, of which Defendant's Exhibits 1, 2 and 3* are photolithographic copies, are part of the court records in the suit [fol. 995] of *Marconi v. Atlantic Communication Company* now pending in the Eastern District of New York, and cannot be removed from such records for the purpose of introduction as evidence in the present case.

Mr. Peters: Plaintiff's counsel states that the said original letters are parts of the files of the said Court and so far as Plaintiff's counsel is concerned he has no power or authority to remove them. Plaintiff's counsel has no objection to the said original letters being removed and made a part of the record in this case.

Mr. Scull: Defendant's counsel notes that the Examiner here is the Clerk of the Court for the Eastern District of New York, and now asks him to state on the record whether or not the letters above referred to are or are not part of the court records here in this District and whether they can be removed from such records for the purpose of offering them as original exhibits in a suit pending in another district.

The Examiner: The exhibits referred to and used in evidence this morning are exhibits in a case in process of trial in the United States District Court for the Eastern District of New York, as shown by the records of that Court with which I am familiar as Clerk. These papers

* Defendant's Exhibits E³, F³ and G³ in *Marconi vs. U. S.*

and exhibits cannot be removed without an order of the Court or the consent of the Court.

Mr. Seull: Defendant's counsel notes that, in view of the foregoing statement of the Clerk, that the objection taken to the introduction of Defendant's Exhibits 1, 2 and 3 as secondary is apparently not well founded; but he states further that if Defendant's Exhibits 1, 2 and 3 are secondary evidence, then he wishes to make the same objection to Plaintiff's Exhibits H-1, 2, 3 and 4 (Claimant's Exhibit No. 150), as was made by Plaintiff's Counsel in reference to Defendant's Exhibits 1, 2 and 3.

Deposition Closed

March 11, 1916, 11 A. M.

Deposition of David Sarnoff, for Claimant, taken at New York, N. Y., on the 11th day of March, A. D. 1916

Direct examination.

By Mr. Peters:

Q. 1. State your name, age, residence and occupation.

A. David Sarnoff, 2063 Mapes Avenue, Bronx, New York; age, 25 years. I am at present assistant traffic manager and contract manager of the Marconi Wireless Telegraph Company of America.

Q. 2. How long have you been employed by the Marconi Company and in what capacity or capacities?

A. I joined the Marconi Company in September, 1906. I have been employed at the beginning in its executive [fol. 996] office at William Street, New York; then as wireless operator on shipboard and shore stations; as inspector in the engineering department; chief inspector of the Company; assistant to Mr. Sammis, onetime chief engineer of our Company; and, as previously testified, am now assistant traffic manager and contract manager of the Company.

Q. 3. How long have you personally been familiar with the apparatus and practices of the Marconi Company?

A. Since 1907.

Q. 4. To what extent, if at all, in 1907 and 1908 was tuned transmitting and receiving apparatus employed by the Marconi Company?

A. Tuned apparatus was employed by the Marconi Company generally at its ship and shore stations at the time referred to.

Q. 5. If untuned or plain aerial apparatus was also employed during these years, please state briefly the purpose for which it was employed.

A. Plain aerial transmitting apparatus was installed on all ship stations then equipped by the Marconi Company and also at some of the shore stations then in use. The purpose for which plain aerial was installed on ship stations was for use in case of emergency. When a ship is in distress, the plain aerial transmitter is found to be a convenient apparatus for instant use. It was also the custom of the Marconi Company at that time, and in some cases still is, to supply batteries for operating the plain aerial induction coil transmitters so that in the event of a ship being damaged and unable to furnish current from its engine room dynamo, the batteries will furnish the auxiliary source of current. At the shore stations the plain aerial transmitters were sometimes used when, for one reason or another, the main tuned equipment might have been temporarily out of commission.

Q. 6. Why did the plain aerial or untuned apparatus provide a convenient auxiliary in case of emergency or distress as I understand you state?

A. Because the plain aerial transmitter produces a highly damped wave, which is easily received on a tuner which need not be sharply tuned, and, in fact, the oscillations produced by plain aerial transmitters very often come in over a very wide range of the tuned receiving apparatus. In fact, the radio regulations of the Department of Commerce suggest, I believe, the use of highly damped waves in times of distress.

Q. 7. What ship and shore stations were operated by the Marconi Wireless Telegraph Company of America during the years 1907 and 1908?

A. The following ship and shore stations were in operation at the time referred to in your question. Shore stations: Cape Code, Mass.; Sagapenack, Long Island; Siasconset, Mass.; Sea Gate, Coney Island, N. Y.; I believe Babylon, Long Island, was still in operation at that time. Ship stations: S. S. Philadelphia, American Line; S. S. New York, American Line; S. S. St. Louis, American Line; S. S. St. Paul, American Line; S. S. Finland, Red Star Line;

S. S. Kroonland, Red Star Line; cable ship, Mackay-Bennett. There may have been one or two others, but I don't recall at this time.

Q. S. Please describe the apparatus employed at these stations, limiting your statements to your own personal observation, either of the apparatus or the knowledge gained by receiving signals from the stations, during the years 1907 and 1908, and in describing the apparatus please refer to any drawings or descriptive matter which you can produce to supplement your testimony.

A. About that time there were several types of equipments generally employed. I produce a drawing (reproduced as Claimant's Ex. No. 151), I have made showing [fol. 997] the arrangements of the circuits which I will describe by referring to the figures. The apparatus then used at the ship and shore stations operated by the American Marconi Company were known as tuned apparatus, being distinguished by certain letters assigned to the different tunes, such as Tune A, Tune B, and also tuned transmitters using motor generators, which were referred to as "power sets."

Fig. 1 of the drawing submitted shows a tuned transmitter using a Tune A transmitting jigger and Tune A condenser. Letter *f* represents the aerial; *A*, the vertical wire connecting the aerial with the secondary of the Tune A jigger; *d'*, which was connected to *E*, the earth. The word "jigger" stood for what we now call "oscillation transformer"; *d* represents the primary of the jigger or oscillation transformer; *e* represents Leyden jars, which constituted the condenser of the closed oscillatory circuit; *G*, the spark gap; *s*, the ten inch induction coil; *a*, the primary source of current; *b*, the transmitting key.

Fig. 1-A shows the Tune B transmitting jigger and condenser; *d'* representing the secondary of the jigger, *d*, the primary of the jigger; and *e* (which I will label now) the Tune B condenser. The remainder of the circuit was the same as in Fig. 1, previously described.

Fig. 3 represents the tuned transmitter using a motor generator; or, in other words, the tuned power set. *f* represents the aerial; *A*, the vertical wire connecting the aerial with the loading coil *g*; *d'*, the secondary of the oscillation transformer, and *E* the earth connection; *f*, *A*, *g*, *d'* and *E* being connected in series. *d* represents the primary of the oscillation transformer; *e* the condenser

of the closed oscillatory circuit; G the spark gap; c the power transformer; b the transmitting key; and a the motor generator furnishing the necessary current to the transformer.

Fig. 4 represents the receiving apparatus known as the Marconi Multiple Tuner, which was used with the magnetic detector. Describing the arrangement of circuits shown in Fig. 4, I would say that f represents the aerial; A the vertical wire connecting the aerial with the loading coil g'; h a variable condenser; j' the primary of the receiving oscillation transformer; and E the earth; the elements previously mentioned being connected in series; j² the secondary of the oscillation transformer; R' a variable condenser; t' an inductance; j² R' and t' representing the intermediate circuit of the multiple tuner; t² an inductance; h² a variable condenser; and M the magnetic detector; t², h² and M forming the detector circuit.

It was the general practice of the Marconi Company to supply both the Tune A and Tune B transmitting apparatus at the same station. The Tune A transmitter provided for a shorter wave length than the Tune B transmitting apparatus, which furnished a longer wave. Separate oscillation transformers or jiggers were supplied to each station for use with Tune A and Tune B transmitters. The condensers of the closed oscillatory circuit were varied in using either Tune A or Tune B. In the case of Tune A, the condenser consisted of six Leyden jars connected in series parallel; in the case of Tune B, the condenser consisted of a number of Leyden jars, varying from twelve to sixteen, the jars being connected in parallel. In some cases an entirely separate tray containing the Tune A condensers was supplied and a separate tray containing Tune B condensers was supplied. In other cases provision was made for reducing the number of jars and changing the connections of the condenser when changing from Tune A to Tune B transmission or vice versa. The apparatus described in Fig. 3, namely the power sets, were then about coming into general use by the Marconi Company, this type of transmitter replacing the earlier type of induction coil transmitter. The oscillation transformers supplied with the power sets were variable as to the number of turns in the primary and secondary and the loading coil was also variable as to turns. Where the tuned transmitting power sets were installed

on shipboard, the induction coil transmitter still remained, but was connected for plain aerial use in time of emergency, as previously described and referred to. The receiving apparatus shown in Fig. 4 consisted, as I have said, of a Marconi Multiple Tuner, frequently called the "Franklin" Tuner. This tuner consisted of three circuits, namely, the open or aerial circuit, the intermediate circuit, and the detector circuit. The inductances and capacities shown and described in each of these circuits were variable.

About August of 1908 the Marconi Company was awarded a contract by the U. S. Revenue Cutter Service for the equipment of the U. S. Revenue Cutter Seneca, and I inspected the apparatus while it was in the course of construction at our shop in New York and also saw it after it was assembled and while it was tested. I produce herewith a diagram (reproduced opposite as Claimant's Ex. No. 154) showing the circuits and connections of the transmitting and receiving apparatus installed on the Revenue Cutter Seneca. This drawing shows that a tuned power transmitting set was installed using a motor generator, plate condensers in oil, an inductively coupled oscillation transformer, and that the receiving apparatus consisted of a magnetic detector and a multiple tuner, previously described.

During the years 1907 and 1908 I made frequent visits to the Marconi station at Sea Gate, Coney Island, and on several occasions operated there for short periods of time, and found that Tune A transmitting apparatus was used almost exclusively. There was no plain aerial equipment installed or used at this station during the time specified or subsequent thereto. I also made frequent visits on the vessels of the American Line previously referred to and found that the ships were equipped with Tune A, Tune B, and, of course, plain aerial sets. I should also add here that wherever a Tune A or Tune B transmitting set was used with a ten inch induction coil that it was possible to use the same coil in a plain aerial manner by simply connecting the one terminal of the secondary of the induction coil to the aerial circuit and the other terminal of the secondary of the induction coil to ground.

I should add that it was the practice of the wireless operators at ship stations to use the separate jigger supplied for Tune B when transmitting on Tune B and to use

the separate jigger supplied for Tune A when using Tune A; and similarly in the case of the transmitting condensers, either the separate bank of condensers supplied in the tray containing the Tune B condensers were used when transmitting on Tune B, and similarly the separate tray of condensers for Tune A when transmitting on Tune A, or else the change in number and connection of the jars was made by the operator where separate trays of condensers were not supplied with Tune A and Tune B transmitters. [fol. 999] Q. 9. Can you produce a photograph showing an installation of what you have defined as Tune A and Tune B apparatus?

A. Yes, sir; I produce herewith a photograph (Reproduced opposite) taken of the interior of the wireless cabin on the S.S. St. Paul of the American Line. It shows two transmitting jiggers, one of which I recognize to be the Tune A transmitting jigger and the other the Tune B transmitting jigger. It also shows two trays of Leyden jar condensers, ten inch induction coil and coherer receiving apparatus, as well as other accessories.

Q. 10. What is the apparatus shown in Figs. 2 and 2-A of your drawing?

A. The apparatus shown in Fig. 2 represents a tuned receiver with a Tune A receiving jigger. I will describe the apparatus by referring to the letters; f represents the aerial; A the vertical wire connecting the aerial with the billi condenser h; d' the primary of the receiving jigger; E the earth; s' representing the secondary of the receiving jigger and js representing a fixed condenser inserted in series with two coils and marked s'. T represents the coherer detector; c' and c² representing choke coils; b local battery; and B the local circuits of the relay tapper and inker, etc.

Fig. 2-A represents a Tune B receiving jigger; d' represents the primary of the Tune B receiving jigger; s' the secondary coils of the Tune B receiving jigger; and js the fixed condenser in series. I have shown in dotted lines billi condenser, which I now mark h, and the reason why I have shown this billi condenser h in dotted lines is because it could and it could not have been used in the manner shown. Some operators preferred to use it; others did not. Separate receiving jiggers were supplied for use when receiving Tune A signals and when receiving Tune B signals. These jiggers were contained in small wooden boxes and

it was the practice of the operators to remove one jigger and install in place thereof the other jigger supplied, depending on the particular tune which they desired to receive.

Q. 11. Can you produce any catalogue or circular describing the Marconi Multiple Tuner illustrated in Fig. 4?

A. I produce printed circular gotten up by the British Marconi Company, entitled "Description of the Marconi Multiple Tuner", which is the same tuner as I have previously referred to in the installation of the U. S. Revenue Cutter Seneca and other stations where it was used.

Q. 12. How does it happen that this circular is issued by the British Company?

A. Because these tuners were designed and manufactured by the British Marconi Company and were purchased by the American Marconi Company.

Mr. Peters: I offer in evidence the drawing produced by the witness, containing Figs. 1 to 4 and request that the same be marked "Plaintiff's Exhibit I, Sarnoff Drawing, Early Marconi Tuned Transmitters and Receivers" (Claimant's Exhibit No. 151).

I also offer in evidence the catalogue produced by the witness and the same is marked "Plaintiff's Exhibit J, Catalogue, Marconi-Franklin Tuner" (Claimant's Exhibit No. 152).

I also offer in evidence the photograph produced by the witness and request that the same be marked "Plaintiff's Exhibit K, Photograph, Marconi Tune A and Tune B Transmitting and Receiving Apparatus" (Claimant's Exhibit No. 153).

I also offer in evidence the blue-print produced by the [fol. 1000] witness showing the apparatus installed on the Seneca, and the same is marked "Plaintiff's Exhibit L" (Claimant's Exhibit No. 154).

Q. 13. Have you made an examination of the original records of the Marconi Company for the purpose of ascertaining the character and type of apparatus employed prior to the time you became connected with the Company?

A. I have.

Q. 14. Have you some or all of such records here?

A. I have a number of such records here.

Q. 15. When do the records show that the Marconi Company commenced commercial business?

A. About 1901.

Q. 16. Please give a list of the stations installed, from 1901 down to the time you became connected with the Company.

A. The records show that the first station was installed on the Nantucket Light Ship on August 1, 1901. Thereafter the following shore and ship stations were equipped by the Marconi Company. Shore Stations: Cape Cod, April 1902; Sagaponack, July, 1902; Siasconset, September, 1902; Babylon, September, 1902; a station at a dock in New York and called "Dock Station, New York", January, 1904; Sea Gate, January, 1906. Ship Stations: S. S. Philadelphia, American Line, November, 1902; S. S. New York, American Line, April, 1903; S. S. St. Paul, American Line, May, 1903; S. S. St. Louis, American Line, August, 1903; S. S. Finland, Red Star Line, August, 1903; S. S. Kroonland, Red Star Line, February, 1904; cable ship Mackay-Bennett of the Commercial Cable Company, June, 1905.

Q. 17. Do the original records show the type and character of apparatus installed at these early stations? If so, will you please refer to such records and state the type and character of apparatus specified in connection with the several stations.

A. I produce shipping order No. 7 dated September 24, 1902, showing the shipment to the Nantucket Light Ship which, as I have said, was equipped with Marconi apparatus, and among the items listed on this shipping order appears the following: "1 No. 35 T jigger", which I recognize to be a transmitting jigger or oscillation transformer; "1 No. 306 jigger", which I recognize to be a Tune A receiving jigger; "2 spare Leyden jars and 6 Leyden jars in portable case", which I recognize to be the transmitting condenser. The item of six Leyden jars referred to is the exact number of jars used for the transmitting condenser of the Tune A transmitter. It was customary to apply spare jars, and this is still the practice of the Marconi Company where Leyden jar condensers are used.

I produce shipping order No. 2, dated September 12, 1902, addressed to the Marconi station at Nantucket, Mass. [fol. 1001] Nantucket, Mass., stands for the station at Siasconset, Mass., as Siasconset is on Nantucket Island, and either of these names are used. Shipping order No. 2 shows the shipment of 12 Leyden-jars, which represents the transmitting condenser.

I also produce shipping order No. 12, dated October 10, 1902, addressed to the Marconi station at Nantucket, showing shipment of $\frac{1}{2}$ dozen No. 306 jiggers, which, as I have previously stated, is the number given to Tune A receiving jiggers.

I produce shipping order No. 22 dated November 3, 1902, addressed to the Herald station, Nantucket, Mass., which is the same as the Marconi station.

The New York Herald was interested in the Marconi station installed at Siasconset or Nantucket Island, and the records of our Company show that the station at Siasconset or Nantucket was sometimes referred to as the Herald station.

Shipping order No. 22, previously referred to, shows the shipment of a No. 306 jigger, which is the Tune A jigger.

I produce shipping order No. 71, dated April 16, 1903 addressed to the Marconi station "D.K.", American Line Dock, New York. This shipping order shows the shipment of "1 T jigger; 6 Leyden jars and tray; a No. 343 jigger," which is the Tune B receiving jigger, and also a "306 jigger", which is the Tune A receiving jigger.

I produce shipping order No. 463, dated May 10, 1905, addressed to the Marconi station at Sagaponack. The ship-[fol. 1002] ping order contains the following: "May 19th, 1 special T jigger; 2 turn primary, 10 turn secondary." I produce shipping order No. B21, dated August 22, 1905, addressed to Marconi station, Sagaponack, showing the shipment of: "50 condenser plates; 4 condenser tanks with covers, clamps and wedges; 2 KW 500 volt transformer with large balls". The condenser plates referred to were used in oil and it is still the practice of the Company to use such condenser plates in oil in transmitting apparatus and the 2 KW 500 volt transformer indicates the use of a power set instead of an induction coil. I produce shipping order B174, dated July 5, 1906, addressed to Sea Gate. This shipping order shows, "1 Tune A T jigger", T standing for transmitting jigger.

I will now refer to the ship stations equipped by the Marconi Company. I produce shipping order No. 98, dated July 27, but the year does not appear on this shipping order. However, as these shipping orders are numbered serially, I would say that No. 98 was dated prior to July 31, 1903, on which date shipping order No. 99, to be later referred to, contained a shipment of apparatus. Shipping order No.

98 shows the shipment to the S. S. Philadelphia of the American Line of "6 new Leyden (jars) only." In addition to this item there appear other items. Shipping order B-91, dated December 14, 1905, also addressed to the S. S. Philadelphia shows the shipment of "1½ kilowatt motor generator set complete; 2 tank condensers complete with 25 plates ea.; 15 spare plates for above; 1 No. 17 T jigger"; I have already described what the "T" stands for.

The next ship equipped was the S. S. New York of the American Line. I have testified that this vessel was equipped in April, 1903, and I produce shipping order No. 54, dated April 4, 1903, addressed to the Marconi Station, S. S. New York, showing the shipment, among others, of the following items: "2 bal. receiver complete with 306 jigger No. 508, relay No. 510, tapper No. 525, base No. 520; 6 Leyden jars and case; 1 T jigger No. 5; 1 billy condenser." I produce shipping order No. 55, dated April 13, 1903, showing the shipment to the S. S. New York of a number of items, among which appears the following: "1 268 jigger No. 501." I also produce shipping order No. B-27, dated September 27, 1905, showing the shipment to the S. S. New York of "1 Billy Farad"; this term has been used in place of billi condenser.

Next I refer to the S. S. St. Paul of the American Line. I produce shipping order No. 95 dated July 21, 1903, addressed to the Marconi station, S. S. St. Paul, showing the shipment, among other items, of the following: "1 306 jigger; 1 No. 5 T jigger No. 501; 1 tray 6 Leyden jars."

Next I refer to the S. S. St. Louis of the American Line. I produce shipping order B-3 dated September 13, 1905, showing as one of the items the following: "No. 1.17 T jigger (Tune B)." I also note on this shipping memorandum the following remark: "Received with thanks. William James Brooker." I also produce shipping order B-84, dated December 1, 1905, addressed to S. S. St. Louis, showing, among other items, the following: "1 tank condenser and 12 plates." I also produce shipping order B-125, dated March 3, 1906, addressed to the S. S. St. Louis, containing as one of the items shipped the following: "1 Leyden tray and 8 jars complete." There also appears a notation on this shipping order as follows: "Delivery on February [fol. 1003] 13." Next I produce shipping order No. 94 dated July 18th, the year left off, but I fix this date as being prior to July 21, 1903, on which date shipping order

No. 95 contained shipment of apparatus to the S. S. St. Paul, previously referred to. Shipping order No. 95 shows the shipment, among other items, of the following: "2 No. 306 jiggers; 1 No. 5 T. jigger; 1 tray of 6 Leyden jars; 2 spare jars only."

I also produce shipping order B-72, dated February 27, 1905, addressed to the Marconi station, S. S. Finland, showing the shipment, among other items, of the following: "1 sliding condenser."

Next I will refer to the S. S. Kroonland. I produce shipping order No. 99, dated July 31st and August 1, 1903, both dates appearing on the same shipping order, which is addressed to the S. S. Kroonland. Among other items shipped, the following appears: "306 jigger; No. 5 T jigger; 1 set 6 Leyden jars and trays; 2 spare jars only; 2 Billy Farads." Next I produce shipping order B-76, dated November 13, 1905, addressed to the S. S. Kroonland, showing, among other items, the following: "12 Leyden jars."

I have up to the present time produced records from the books containing shipping orders, but I will now refer to a letter book of the Marconi Company in which appears water copies of private letters written by Mr. John Bottemley, vice president of the Marconi Company, and also copies of business communications written by Mr. W. W. Bradfield, then chief engineer of the American Marconi Company. I am familiar with Mr. Bradfield's handwriting and recognize on page 229 of the book referred to a copy of a letter written by Mr. W. W. Bradfield in his own handwriting, which is as follows:

"Apl 8th 2.

Marconi's Wireless Telegraph Co., Ltd.,
18, Finch Lane, S. C.

GENTLEMEN:

It was decided at a meeting at which Mr. Morse, Mr. Saunders, Mr. Marconi, myself and others were present this morning, to go ahead and equip the Long Island Station at Bridgehampton. Mr. Marconi will, upon his arrival (he leaves tomorrow on the Majestic), fully advise in this connection.

Kindly supply at once apparatus as per list appended and make chargeable to the Marconi Wireless Telegraph Co. of America.

Yours faithfully, W. W. Bradfield."

Apl. 8th 2.

Appendix.

Aerial & Fittings

- 6 prs. of Ebonite rod insulators
- 1 Bradfield type insulator
- 220 yds. 7 18 bare tinned Copper wire.

Transmitting

- 2 10" coils
- 1 Switch key
- 1 Tune A T jigger
- 12Q Leyden jars and 1 special box to hold 6 ditto.

[fol. 1004] *Receiving*

- 2 Reers. complete in screening boxes
- Unbalanced relays & 306 jiggers
- 1 Morse Inker with switches & bell complete
- 2 Boxes of 10 tested coherers
- 1 Set testing shunts
- 1 Aerial plug
- 3 Aerial lugs
- 2 Adjustable (small) condensers
- 2 30 ft. Reevg. Inductances.

W. W. B."

A. (Continuing.) While the figure "2" only appears after the date, Apl. 8th, it was written, as a matter of fact, in the year 1902, the letters of that time having "190" printed and of course this did not copy.

It Is Stipulated by counsel that the foregoing read into the record is a true copy of the letter appearing in the book, and that the book need not be offered in evidence.

A. (Continuing.) I have also made a search of the Company's circulars and general orders relating to the general operation of its stations, and produce Circular No. 37, which reads in part as follows: "The following stations are directly controlled by the Marconi Wireless Tele-

graph Company of America and are 'This Line' stations." A number of ship and shore stations and their radio code letters are shown, and alongside of each station under the heading "Appar", which means apparatus, are marked the letters "TA" or "PA" or "Various" or "PA and TA". From my personal knowledge of the terms used by the Marconi Company during my employ I define "PA" to stand for "Plain Aerial"; "TA" to stand for "Tune A" and "Various" meaning that more than plain aerial and Tune A were used. Alongside of the names of the American ship and shore stations the following notations appear: "New York, TA"; "Philadelphia, TA"; "St. Louis, TA"; "St. Paul, TA"; "Finland, TA"; "Kroonland, TA"; "Sybarita, TA". Alongside of the following shore stations, Babylon, Cape Cod, Dock Station New York, Great Neck, Nantucket, Sagaponack, Siasconset, the letters "TA" are shown in each case, which shows that Tune A apparatus was installed at all of the stations previously mentioned. I also produce memorandum of the Marconi Wireless Telegraph Company of America, which is part of the general order book and dated January 3, 1905, which reads as follows:

"Marconi Wireless Telegraph Company of America
Memorandum

To Officer in Charge,
Marconi Telegraphs,
(Issued to Ship Stns. Only.)

Owing to the existence in the vicinity of Sagaponack and Babylon, N. Y. of certain apparently irresponsibly operated wireless telegraph stations, operators of Marconi ship-stations, when communicating with this Company's stations at the above mentioned points, will, under no circumstances, [fol. 1005] omit the Tune A. X-Stopping device, which in order to eliminate any possible disturbances emanating from the sources referred to, must be used in its entirety.

Marconi Wireless Telegraph Company of America,
27 William Street, New York.

January 3rd, 1905."

A. (Continuing.) I also produce memorandum No. 61, from the general order book, dated April 26, 1905, which reads as follows:

"Marconi Wireless Company of America
Memorandum 61

To the Officer in Charge,
(Issued to all stations.)

Please note that the auxiliary yacht "Vahalla" (call letters VH) is being equipped with the Marconi Wireless Telegraphs and will sail from New York, May 16th, 1905. This vessel is classed as an 'other line' station and will have all the advantages of such, but is not required to retransmit.

Ordinary private messages to and from this station will take precedence over business of a like description to or from other offices.

The "Vahalla" is equipped with tunes "A" and "B". Stations ordinarily using tune "A" will 'stand by' and communicate by this means unless otherwise instructed. Siasconset will use Tune B only.

Marconi Wireless Telegraph Company of America,
N. Y. April 26, 1905."

It Is Stipulated by counsel that the foregoing are true copies of the originals produced by the witness and that the originals need not be offered in evidence.

Mr. Peters: I offer in evidence a copy of Circular No. 37 produced and referred to by the witness, and it is stipulated that the said copy may be used instead of the original and that the original need not be offered in evidence. The same is marked "Plaintiff's Exhibit M, Marconi Circular No. 37, dated August 16, 1904 (Claimant's Exhibit No. 155).

I also offer in evidence the original shipping orders produced and referred to by the witness, the same being marked collectively, "Plaintiff's Exhibit N, Marconi Shipping Orders, Tuned Apparatus, referred to by the witness Sarnoff." In connection therewith I offer to produce for defendant's counsel all shipping orders during the period covered by those offered in evidence so far as they are now in existence (Claimant's Ex. 156).

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Q. 18. Are you familiar with the so-called quenched spark gap apparatus made by the Marconi Company in recent years?

A. I am.

[fol. 1006] Q. 20. Mr. Sammis, testifying in this case at page 199 of the printed record, stated: "Practically the only time that the coupled sets were used was when from storm or damage the antenna insulation became so low as to prohibit the spark. . . . The station at Sagaponack, New York, is a particular example. This station operated with an inductance coil sparking directly into the antenna and earth up to the time the plain aerial was prohibited by law." Speaking now from your own personal knowledge, what can you say as to the truth of that statement?

A. The statement made by Mr. Sammis, to which you have just referred is untrue. Tuned apparatus was used at all ship and shore stations of the Marconi Company considerably prior to 1912, referred to in Mr. Sammis' statement. During the years 1907 and 1908 I frequently went on board the vessels of the American Line equipped with our system while these vessels were in port, and have seen tuned apparatus on these vessels. During the same time I also operated for various periods at the Marconi station at Sea Gate, where, I have already testified, tuned apparatus was used exclusively. In 1909 I was an operator at the Marconi station at Siasconset, Mass. I found tuned transmitting and receiving apparatus there and used only tuned transmitting and receiving apparatus during the time that I was there, which was about fifteen months in all. During my stay at Siasconset I received signals and messages from the Marconi station at Sagaponack, Long Island, and from the character of the signals received I know that the transmitting apparatus used at Sagaponack was tuned. In the early part of 1910 I was appointed operator in charge at the Marconi station erected on the roof of the Wanamaker Building in New York and held that position for about a year's time, during which I used tuned transmitting and receiving apparatus exclusively. The same statement as to tuned apparatus is true of the sister station on the roof of the Wanamaker Building at Philadelphia, where I made frequent inspection. I don't recall at this moment the time when I made a trip across the Atlantic on the S. S. New York, but it was only one trip, and I believe some time during 1909 or 1910, when I relieved the regular operator on the ship.

During that trip across I used tuned apparatus on the New York, and from the character of the signals received from the stations at Sea Gate, Sagaponack, Siasconset and Cape Cod, Mass., I know that the signals transmitted by these stations were tuned. It was the general practice of the Marconi Company at that time, and it still is, to supply tuned receiving and transmitting apparatus to all its stations, ship and shore. I have made numberless inspections of the various stations of this Company subsequent to 1910 and have found tuned apparatus in use at such stations as I inspected.

Q. 21. Speaking now from your own experience, how [fol. 1007] efficient, compared with the untuned apparatus, was the tuned apparatus which you have described and shown in your drawing, Plaintiff's Exhibit I (Claimant's Ex. No. 151)?

A. The Tune A apparatus which I used at Sea Gate for transmitting and which tune I received at Sea Gate from ships transmitting on this tune was superior to the plain aerial or any other untuned circuit at this point, for the reason that the Tune A signals were extremely sharp and enabled operators, including myself to receive messages while others in the same vicinity were working on different tunes or on untuned circuits. The wave length of the Tune A transmitting apparatus was, I believe, somewhere in the neighborhood of 180 meters, and I recall instances where I conducted a great volume of traffic with ships communicating with Sea Gate, while the United Wireless station situated only several blocks away from Sea Gate, namely, at "Dreamland," Coney Island, transmitted, and while also the United Wireless station on the roof of the building at 42 Broadway, New York, transmitted messages. For this reason Tune A was used exclusively at Sea Gate with the ships in its vicinity. This fact was recognized by operators generally, and is evidenced by the circulars which I have already produced, showing that with certain stations Tune A was required to be used exclusively.

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During my stay at Sea Gate the more powerful apparatus was coming into general use, and the tendency of those times was to abandon Tune A, because it was specially designed to operate with the equipment described in Plaintiff's Exhibit I (Claimant's Ex. No. 151). I recall many

instances where it was impossible for me to receive messages from the ship while they were transmitting to Sea Gate except when they used Tune A. As a result of this, efforts were made by the American Marconi Company to induce the vessels of foreign registry but equipped with Marconi apparatus to still continue the use of Tune A regardless of the more powerful apparatus that they carried on these vessels. As Tune A operated on an extremely short wave length, a number of the foreign vessels referred to made provision for the continuance of Tune A, in some cases using only a portion of their antenna, and where this was not convenient special antennae were installed in addition to the regular antennae on these vessels, so that Tune A signals could be transmitted.

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The witness states that all of the testimony given in the preceding answer is of my personal knowledge.

Q. 22. You have referred to different types of transmitting and receiving apparatus in your drawing, Plaintiff's Exhibit I (Claimant's Ex. 151), as tuned apparatus. In what sense was this tuned apparatus? How did you use this expression?

A. By the expression "tuned apparatus," I mean that in the case of the transmitter the closed oscillatory circuit is tuned to the same period as the aerial or open radiating circuit. The same answer applies with regard to the receiving apparatus. In the case of the transmitting apparatus, sometimes the aerial or open radiating circuit was tuned to the period of the closed oscillatory circuit, and at other times the closed oscillatory circuit was tuned to the period of the aerial or open radiating circuit. This was a matter of preference.

Q. 23. Referring to the apparatus known as Tune A and Tune B transmitting apparatus what can you say as to whether or not the open and closed circuits which you have described were tuned or whether the jigger coils forming a part of these circuits were tuned?

A. In the case of the Tune A transmitting apparatus, the period of the open circuit was determined by the number of windings on the secondary of the Tune A jigger, and the aerial was specially constructed having a given dimension. The closed circuit was predetermined by having a definite value of inductance in the primary of the jigger

and by using the proper capacity. In the case of Tune B, a different jigger was used, having a predetermined value of inductance in the open circuit, and the closed circuit was tuned by varying the number of Leyden jars used in the closed circuit condenser until maximum resonance was obtained.

Cross-examination.

By Mr. Scull:

X Q. 24. In 1906, how old were you?

A. I was 15 years old.

X Q. 25. At the time your duties brought you directly into contact with the apparatus used by the Marconi Company, which, I understand, was in 1907, what had been your educational qualifications so that you could understand the apparatuses being used?

A. I had been a graduate of Public School, had taken up a term of study at De Witt Clinton High School, and from the time that I entered the employ of the Marconi Company in 1906 I devoted myself studiously to the radio art and spent as much of my time as I possibly could at the laboratory of the Marconi Company, which was then situated at Front Street, New York. I read books on electricity and such literature as was within my understanding regarding wireless telegraphy.

X Q. 26. In 1907 were all of the types of apparatus illustrated in Plaintiff's Exhibit I (Claimant's Ex. 151) used by the Marconi Company?

A. Not all of it. At that time and a year or two prior to 1907 the coherer receivers were being discarded, the magnetic detector having then taken its place, but the Tune A and Tune B transmitting apparatus was then still in use.

X Q. 27. And was the apparatus illustrated in Figs. 3 and 4 used in 1907?

A. That shown in Fig. 3 was. That shown in Fig. 4 did not, I believe, come into general use until some time in 1908.

X Q. 28. I am not asking about the general use. I am asking whether any of it was used.

A. Cut out the word "general"; came into use in 1908.

X Q. 29. To your knowledge, how long prior to 1907, if at all, had the apparatus of Fig. 3 been used by the Marconi Company?

A. Only insofar as the records that I have produced can I answer this question.

X Q. 30. What do those records show?

A. The records show that apparatus described in Fig. 3 was used at Sagaponack, Long Island and Siasconset, Mass., and I know that tuned apparatus having the circuits described in Fig. 3 were used at the high power station of the Marconi Company at Cape Cod.

[fol. 1009] X Q. 31. Do you know at what date these were put in?

A. I could tell you from the records.

X Q. 32. Do it.

A. The station at Sagaponack, Long Island,—well, I have already answered that question in my previous testimony.

X Q. 33. Well, say it again.

A. The station at Sagaponack, Long Island, was erected in July, 1902; Siasconset, September, 1902; and Cape Cod, April, 1902. These dates I am quoting from the Marconi Company's records.

X Q. 34. Do you understand that the records show that the apparatus of Fig. 3 was installed in those stations when they were erected?

A. I don't understand this to be so with respect to Fig. 3, but my answer refers now only to the dates when these stations were erected.

X Q. 35. From the records, when was apparatus like that shown in Fig. 3 installed in Sagaponack?

A. Such records as I am able to produce at this time show that on May 10, 1905, under shipping order No. 463, apparatus such as described in Fig. 3 was sent to Sagaponack. I should also add that shipping order B-21 dated August 22, 1905, shows that apparatus was shipped to Sagaponack of the character described in Fig. 3.

X Q. 36. What is there on these two shipping orders on which you base your statement?

A. The following items: "1 special T jigger having 2 turn primary and 10 turn secondary; 50 condenser plates; 4 condenser tanks with covers, clamps and wedges; 2 KW 500 volt transformer with large balls, and 1 choke coil complete."

X Q. 37. Where is this choke coil shown on Fig. 3 of your drawing?

A. Well, it is not shown in Fig. 3 of my drawing; it was the practice in some cases and still is to use a choke coil in the primary of the power transformer. I did not show it

in Fig. 3 because a choke coil was not employed at each station using a power set.

X Q. 38. Is there anything on the shipping lists which you have referred to which would show that the oscillating transformer or jigger was variable?

A. Yes.

X Q. 39. What is it?

A. Because every oscillation transformer which has a number of turns can be varied by using as many or as few of the turns as is desired. This is done by tapping off the desired number of turns.

X Q. 40. Is that true also of the coil d' in Fig. 1 of Plaintiff's Exhibit I (Claimant's Exhibit 151)?

A. That is true of coil d' in Fig. 1, excepting that I have already testified that the jigger used in Fig. 1 was predetermined as to its number of turns, and it had to be used in its entirety in order to maintain resonance between the open radiating circuit and the closed oscillatory circuit of the apparatus described in Fig. 1.

X Q. 41. But there is nothing on the shipping list to which you have referred with reference to the station at Sagaponack which shows that the oscillation transformer was variable in that case as compared with the unvariable type as illustrated in Fig. 1 of Plaintiff's Exhibit I (Claimant's Ex. 151); isn't that so?

A. Except that the jigger shown in shipping order No. 463 says "special T jigger", and it is to be understood that in 1905 jiggers or oscillation transformers then constructed for use with power sets would not be made fixed because at a shore station where apparatus is installed, it could not then be readily determined as to the exact number of turns required with the aerial.

[fol. 1010] X Q. 42. Was the transmitter of Fig. 1 installed in connection with shore stations to your knowledge?

A. It was, to my knowledge.

X Q. 43. But those oscillation transformers were sent out with fixed coils?

A. They were.

X Q. 44. In view of this, how do you know, then, that the special jiggers of Fig. 3 were necessarily variable?

A. Because a number of the jiggers shown in Fig. 3 were still in use in 1907 and 1908, when I had personal knowledge of them.

X Q. 45. You had no personal knowledge of these special jiggers at the time they were shipped in 1905?

A. I had not.

X Q. 46. You don't know what they were, as a matter of fact?

A. Those which remained in service and were still in use as of 1907 and 1908, during the time that I was employed, I have knowledge of.

X Q. 47. Do you know what was the special jigger referred to on shipping order No. 463?

A. No more than I have described previously.

X Q. 48. And you don't know, as a matter of fact, whether or not that special jigger had variable coils, do you?

A. I have not seen it.

X Q. 49. Now, referring to the apparatus shown in Fig. 1 of Plaintiff's Exhibit I (Claimant's Ex. No. 151), I think you have said that the condensers represented by the letter *e* were a set of six jars in a tray. Am I correct in so understanding your testimony?

A. Yes, sir.

X Q. 50. Was there any means supplied to the operator for varying the capacity of this condenser?

A. He could use as many less than six as he desired by simply cutting out the condenser.

X Q. 51. What would guide him in determining whether to cut out the condenser or not?

A. The operator was not required to tune the apparatus, this having been attended to by the installing engineer.

X Q. 52. As a matter of practice, was a variable number of jars connected in the circuit to form condensers of different capacities?

A. Still confining my reply to your question as it refers to Fig. 1, I would say that the number of jars used in the closed circuit of the Tune A transmitter was six.

X Q. 53. Did you ever see any apparatus constructed according to Fig. 1 in which a greater or less number of Leyden jars was used at the point *e* on Plaintiff's Exhibit I?

A. I have never seen this circuit operated with any different number of jars than six.

X Q. 54. I call your attention to shipping order No. 7, forming part of Plaintiff's Exhibit N (Claimant's Ex. 156), and ask you what the notation, "No. 5 T jigger No. 35" means.

A. It is my understanding that the item quoted by you refers to Tune A transmitting jigger.

X Q. 55. What does "No. 306 jigger" mean on the same shipping order?

A. It is my understanding that a No. 306 jigger means a Tune A receiving jigger.

X Q. 56. And what does a "No. 268 jigger" mean?

A. It is my understanding that No. 268 jigger was a special jigger used in connection with the coherer detectors.

X Q. 57. On shipping order No. 22 I see "No. 301 jigger". What was that?

A. This must have been also a special receiving jigger used in connection with coherer receivers.

X Q. 58. Am I correct then in understanding that the Marconi Company made certain standard fixed jiggers [fol. 1011] which were used in the apparatus shown in Figs. 1 and 1-A of Plaintiff's Exhibit I (Claimant's Ex. No. 151)?

A. You are correct.

X Q. 59. And were these fixed jiggers of identical construction used alike in ship and shore stations of the different Marconi installations?

A. Insofar as the circuits relate to Fig. 1 and Fig. 1-A, it is my understanding that this was the case.

X Q. 60. And does the jigger include the coils d' and d of Figs. 1 and 1-A of Plaintiff's Exhibit I (Claimant's Ex. No. 151)?

A. Yes, sir.

X Q. 61. And did the Marconi Company also have a fixed jigger of identical construction which was used alike in ship and shore stations in the receiving apparatus shown in Figs. 2 and 2-A of Plaintiff's Exhibit I (Claimant's Ex. No. 151)?

A. Yes; but I should add that the jiggers shown in Fig. 2 and Fig. 2-A were not of identical construction just the same as the jiggers shown in the transmitting circuits of Fig. 1 and Fig. 1-A were not of identical construction.

X Q. 62. Can you identify by a number used on the shipping lists which you have produced the type of fixed jigger used in the apparatus of Fig. 1 of Plaintiff's Exhibit I (Claimant's Ex. No. 151)?

A. It is my understanding that the jigger known as Type 5 was a Tune A transmitting jigger shown in Fig. 1.

X Q. 63. Please answer the same question in reference to the jigger shown in Fig. 1-A?

A. It is my understanding that the jigger known as Type 17 was used in Fig. 1-A.

X Q. 64. And please answer the same question in reference to the jiggers shown in Figs. 2 and 2-A?

A. It is my understanding that the jigger known as Type 306 was used with Fig. 2, and the jigger known as Type 343 was used with Fig. 2-A.

X Q. 65. Did the length of the wire A, and the capacity of the aerial f in Fig. 1 vary with different installations?

A. I have already testified that the aerials were specially constructed of a given length when used with apparatus described in Fig. 1.

X Q. 66. And was this length the same for all stations using the apparatus of Fig. 1, whether a land or ship station?

A. I believe not; depending upon the height of the antenna which, of course, determines its capacity.

X Q. 67. Then, was the capacity of all the aerials in ship or shore stations using the apparatus of Fig. 1 alike?

A. I should say no; but the capacity and inductance, which in combination form the period of the aerial, were made alike.

X Q. 68. How was this done?

A. By the mathematical formula which covers wave lengths, namely $\lambda = 2\pi\sqrt{LC}$. C stands for capacity in microfarads and L stands for inductance in microhenries.

X Q. 69. What gives the inductance to the aerial circuit of Fig. 1?

A. The length of the aerial f, the length of the vertical wire A, the number of turns in primary of the jigger d' and the length of the wire connecting the bottom of the coil d' with the earth E, and the manner in which the coils shown at d' are wound.

[fol. 1012] X Q. 70. I call your attention to the last part of Q. 23, in which you stated that: "In the case of Tune B . . . the closed circuit was tuned by varying the number of Leyden jars used in the closed circuit condenser until maximum resonance was obtained." Who was it who varied the number of Leyden jars in the manner which you indicate in that answer? Would it be the operator or the constructor of the apparatus?

A. Usually the man who installed the apparatus or the man who inspected the apparatus from time to time.

X Q. 71. And how many Leyden jars were normally used as the condenser in this circuit?

A. From 12 to 16 jars.

X Q. 72. You personally never saw any of the so-called Tune A and Tune B apparatus in use prior to 1907, did you?

A. I did not.

X Q. 73. Are there any records in the office of the Marconi Company that you have searched which show any more definitely than the shipping lists which you have produced the character of the apparatus which was used in making up Tune A and Tune B circuits on Plaintiff's Exhibit I?

A. There may be, but I have not been able to locate them because of the voluminous records kept by so large an organization as the Marconi Company.

X Q. 74. Were there no drawings or other specification of the construction of the different parts of the apparatus of the Tune A and Tune B circuits other than the shipping lists which you have produced in the files of the Marconi Company?

A. There may have been or there may be now, but I have not, up to the present, been able to locate them.

X Q. 75. Have you made a search for such drawings?

A. I have.

X Q. 76. At the time you received signals from the station at Sagaponack, who was the operator for the Marconi Company at that station?

A. There were three operators at Sagaponack. I recall the name of the operator in charge who was Mr. W. W. Ward, but I am not quite clear at this time as to who his assistants were then.

X Q. 77. How long was Mr. Ward in charge of that station to your knowledge?

A. I believe that Mr. Ward had been in charge of Sagaponack from 1904 or 1905 up to, I think, 1914.

X Q. 78. Is Mr. Ward now in the employ of the Marconi Company?

A. He is.

X Q. 79. Where is he located?

A. He is now in charge of the high power station of the Marconi Company at Belmar, New Jersey.

X Q. 80. And he is the man who had charge of the operation of that station during the period you have stated and

who would know what apparatus was used there, would he not?

A. He is.

X Q. 81. Is there any man now employed by the Marconi Company who personally supervised or erected any of the Tune A or Tune B apparatus of Plaintiff's Exhibit I prior to 1904?

A. I believe there is, but I cannot be certain as to this man's supervision or erection of Tune A and Tune B apparatus prior to 1904.

[fol. 1013] X Q. 82. Who is that man?

A. Mr. A. H. Ginman.

X Q. 83. And where is he now located?

A. He is now general superintendent of the Marconi Company at San Francisco, California.

X Q. 84. I call your attention to X Q's. 65 to 69 inclusive, and your answers thereto, and ask you whether in replying to such questions you were answering from your personal knowledge or from information derived from others?

A. The questions asked in X Q. 67, X Q. 68 and X Q. 69 refer to principles of wireless telegraphy and methods of constructing apparatus and tuning. The answers I have given to the questions just numbered are of my knowledge, but as to the methods employed for shortening the aerials or tuning the apparatus prior to 1907 I have only answered insofar as the information I have gained during my connection with the Marconi Company has enabled me to answer. Subsequent to 1907 I have seen the practices described in various communications and instructions.

X Q. 85. When were these communications and instructions prepared that you refer to in your last answer?

A. I don't know when they were prepared, but I have previously testified, I believe, that I was in the executive office of the Marconi Company immediately after my joining that Company, and during that time I had seen communications exchanged between the engineers of the Company and the station operators or managers referring to the tuning of apparatus.

X Q. 86. When you made the search that enabled you to produce the shipping lists which you did produce, did you also make a search for such letters or instructions that you have just referred to?

A. I did; but unfortunately a large amount of the Company's correspondence had been destroyed about a year

or two ago, for the reason that we moved into new quarters and there was so much correspondence that it took up too much room, and, as is customary with large corporations, correspondence of ordinary operations is destroyed periodically.

X Q. 87. But the corporation didn't destroy these shipping lists showing, for instance, that two Leyden jars had been shipped some time in 1904, and the like, did it?

A. It did not, and I don't know why.

X Q. 88. Then there is nothing, so far as you know, that you can produce from the records of the Marconi Company to show that prior to 1907, when your personal experience began, the Marconi Company did, in fact, by its engineers and constructors vary the inductance and capacity of the antenna to suit the fixed jiggers and the fixed oscillatory circuits which it supplied in the construction shown in Figs. 1 and 1-A of Plaintiff's Exhibit I (Claimant's Ex. No. 151), is that true?

A. So far as I know. I am not able at this time to produce any more records than I have already produced.

X Q. 89. And so far as you know, the records which you have produced are the best evidence which the records of the Marconi Company now contain of this so-called tuning which you have described?

A. So far as I know, they are.

X Q. 90. Supposing that the operator's apparatus was equipped with the separate jiggers and the separate condensers as you have testified were sometimes supplied, so that the operator could use Tune B and Tune A circuits, how long would it take an operator to shift from one to the other of these tunes?

A. I should say a minute, or possibly less, because the plugs were conveniently arranged so that all the operator [fol. 1014] was required to do was to take his leads and plug it in the proper socket as is shown in the photograph which I have previously referred to, Plaintiff's Exhibit K (Claimant's Ex. No. 153).

X Q. 91. Of course, you had no personal knowledge that the apparatus was arranged with these sockets and plugs prior to 1907?

A. Prior to 1907, I had not.

X Q. 92. Is there any evidence in these shipping lists which you have produced which leads you to believe that such sockets and plugs for such quick shifting from one

tune to the other were supplied prior to 1907 by the Marconi Company?

A. Yes.

X Q. 93. What is that evidence?

A. The evidence of the Tune A and Tune B jiggers themselves, which I had seen in use subsequent to 1907, and the method of their construction, which I had subsequently seen.

X Q. 94. I ask you whether there is any evidence in the shipping lists which you have produced of the specific construction of the jiggers referred to on such shipping lists at the time such shipments were made?

A. And my answer is yes, for the reason that when I saw a Tune B jigger or a Tune A jigger, I mean all the parts of such jiggers and part of the jiggers themselves are the connecting terminals.

X Q. 95. But you had no personal knowledge of what was actually shipped on any one of those shipping lists, have you?

A. I have already testified that prior to 1907 I had not seen the apparatus shipped.

X Q. 96. Then, when you say that you find evidence on the shipping lists of the construction of the jiggers, you are, as a matter of fact, supplying after-acquired knowledge that is to say, knowledge acquired after 1907, to a certain name which you find on those shipping lists, isn't that true?

A. Yes.

X Q. 97. Have you any knowledge of the publication date of the catalogue, Plaintiff's Exhibit J (Claimant's Ex. 152)?

A. I don't know the exact date, but believe it to be prior to 1908; and further offer to obtain the exact date of publication from the British Marconi Company.

X Q. 98. When you examined the shipping lists from which you produced those embodied in Plaintiff's Exhibit X (present case, Claimant's Ex. No. 156), did you find that about the same dates as covered by those which you did produce, such shipping lists also included items showing that plain aerial transmitting and receiving apparatus was being sent to the various stations of the Marconi Company?

A. I don't recall at this minute the contents of the shipping orders which I have not produced, but I believe that

Mr. Peters has offered to produce the books from which I took the records offered in evidence.

X Q. 99. Then, when you made this search, nothing impressed your mind except the stuff which you have produced here, is that true?

A. There were many other records showing the shipment of tuned apparatus being sent to our affiliated company in Canada, but I confined myself almost entirely to the shipping orders showing apparatus sent to the American Company's ship and shore stations.

X Q. 100. I call your attention to shipping list No. 94 of Plaintiff's Exhibit N (Claimant's Ex. 156), and particularly to an item thereon reading as follows: "1 plain aerial jigger", and ask you what that item means to you?

A. So far as I am able to interpret the particular item [fol. 1015] referred to, I should say that this was an inductance coil supplied to the station on S. S. Finland.

X Q. 101. So that coils which were used in plain aerial apparatus were also called jiggers by the Marconi Company?

A. Apparently they might have been so mistermned; in this particular case it would appear so, because the term jigger stands for oscillation transformer and has been referred to ever since my connection with the Marconi Company as representing an oscillation transformer, and in plain aerial no tuned transmitters or oscillation transformers as we understand them are employed.

X Q. 102. But prior to 1907 you have no knowledge of the use of any terms by the Marconi Company. You don't know, as a matter of fact, whether or not this term "jigger" here was or was not properly or improperly used, nor do you know what it means, any more than you know exactly what the other jiggers referred to which you have specifically pointed out mean.

A. I believe I have already answered you several times that information I have obtained with regard to the Marconi Company's apparatus was obtained subsequent to 1906, when I joined them.

X Q. 103. Did you ever inspect the station at Sagaponack?

A. I did.

X Q. 104. When?

A. Not until 1913, I believe.

X Q. 105. Was the station equipped with plain aerial apparatus at that time?

A. It was not.

X Q. 106. Have you any information as to whether it ever was equipped with plain aerial apparatus?

A. I have no information at this time, but believe that it was equipped with plain aerial apparatus for emergency purposes or breakdown purposes some time or other during the existence of that station.

X Q. 107. Won't you please tell us again just why plain aerial apparatus was used by the Marconi Company as emergency or break-down apparatus?

A. Insofar as shore stations are concerned the answer is that alternating current is supplied to the power transformer and this alternating current is produced by a motor generator. At some stations, namely, Cape Cod, Siasconset and Sagaponack, the electrical current is generated at the station; therefore, if the engine breaks down or the motor generator, for one reason or another, becomes inoperative, the station is out of business except for the use of plain aerial which can be very readily set into operation by operating the coil from the batteries which are supplied at each of the stations mentioned. Insofar as ship stations are concerned, it has been the practice of the Marconi Company in America, and its affiliated companies as well, to supply a reserve source of power consisting in most cases of 12 chloride accumulators giving a voltage of about 25 or 26, and these accumulators were charged from the ship's dynamo and used in cases of emergency when the ship's dynamo, for one reason or another, failed to deliver the required amount of direct current. This was the case when the S. S. Republic sank and, I believe the same is true of the S. S. Titanic, and there are a great number of instances where these reserve batteries and plain aerial induction coils were used for distress purposes.

X Q. 108. I presume that the motor generator apparatus you are referring to is that shown in Fig. 3 of Plaintiff's Exhibit I (Claimant's Ex. 151), is that true?

A. Yes.

[fol. 1016] X Q. 109. Now the apparatus shown in Fig. 1 of Plaintiff's Exhibit I (Claimant's Ex. 151) operates with a battery, does it not?

A. It can operate with a battery, but in practice it was operated from the ship's dynamo current in the case of ship

stations and from the current supplied by the larger amount of batteries installed at shore stations, where no direct current was available from power houses.

X Q. 110. Then, as I understand your testimony, plain aerial transmission sets were used as emergency sets in connection with the apparatus shown in Fig. 1 and also in connection with the apparatus shown in Fig. 3 of Plaintiff's Exhibit I (Claimant's Ex. 151)?

A. Yes, sir.

X Q. 111. Was an apparatus like that shown in Fig. 1 of Plaintiff's Exhibit I (Claimant's Ex. 151) ever used as an emergency set in connection with the apparatus shown in Fig. 3 of Plaintiff's Exhibit I?

A. When apparatus described in Fig. 3 was installed at ship and shore stations, such induction coil transmitters as still remained at ship and shore stations would be used as plain aerial in times of distress, for the reason that plain aerial creates a more disturbing wave, this type of transmitter producing highly damped oscillations. I should also add that apparatus such as described in Fig. 3 may be employed for distress purposes if the current from the engine room is available. In fact, if current is available, it would be an advantage to use apparatus such as described in Fig. 3, because the motor generator set is of greater power and therefore would most likely negotiate much longer distances.

X Q. 112. Is the reason for using a plain aerial as an emergency set based on the fact that it sends out the highly damped waves or because it will transmit to a greater distance with the same energy as the apparatus shown in Fig. 1?

A. You are referring now to what period of time?

X Q. 113. I am referring to the period of time that you have been talking about when plain aerial was used as emergency sets in connection with Marconi Company apparatus.

A. When plain aerial was used in times of emergency, it was used because of the two reasons I have already given: First, that it could operate from batteries when the main source of power failed, and secondly because it produces a highly damped wave.

X Q. 114. Does the apparatus of Fig. 3 produce a highly damped wave or not?

A. That, of course, depends on the type of spark gap employed and the relation between the primary and secondary of the oscillation transformer, that is to say, its coupling, and, moreover, the character of the waves emitted by the apparatus described in Fig. 3 would depend upon the proper design arrangements and tuning of the apparatus shown.

X Q. 115. Well, as Fig. 3 was constructed and put up by the Marconi Company within your knowledge, was it constructed and arranged so as to produce damped or undamped waves?

A. Your term "undamped" is misleading, in that the word "undamped" is applied to what is commonly known as sustained or continuous oscillations, but I would say that the apparatus as constructed in Fig. 3 produced a wave considerably less damped than plain aerial apparatus.

X Q. 116. What was the particular advantage following from the use of plain aerials as emergency sets because they produced highly damped waves as you have said?

A. The advantage was that operators at the receiving [fol. 1017] stations would receive the damped oscillations over a much greater range of their receiving tuners. To make my answer clear, I would say that when an operator at a receiving station tunes his receiver to 600 meters, for example, he would receive messages or signals transmitted by apparatus described in Fig. 3 on the particular adjustment of his receiving tuner, but that if a message or signals were transmitted by apparatus shown in Fig. 3 on a wave length of, say, 500 meters, he probably would not receive such signals on his 600 meter receiving adjustment. In the case of plain aerial, the signals from the plain aerial would, as I have said, be received at points other than the particular adjustment for which the operator may set his receiving tuner. Therefore, in case of distress, it is a decided advantage to have distress signals promptly received and attention given.

X Q. 117. Did you ever operate an apparatus such as shown in Fig. 1 of Plaintiff's Exhibit I (Claimant's Ex. No. 151)?

A. I have.

X Q. 118. Did you ever receive on such apparatus, or, rather, on what I understand is the corresponding receiving apparatus shown in Fig. 2, messages sent out from plain aerials?

A. As I have said, I have operated apparatus shown in Fig. 1 and have received signals from transmitting apparatus such as described in Fig. 1, but I have not used for commercial purposes the receiving apparatus shown in Fig. 2.

X Q. 119. Have you ever used any receiving apparatus of the coupled circuit type in which neither the inductance nor capacity of a closed circuit was variable nor the inductance nor capacity of the aerial was variable?

A. I have not.

X Q. 120. What is the "Tune A X-Stopping Device" which appears in the instructions sheet dated June 3, 1905, reproduced in your answer to Q. 17?

A. The "X-Stopper" was an inductance coil specially arranged having various "tap offs" and used by the Marconi Company in its earlier receiving installations. It was claimed for this piece of apparatus that it considerably minimized the effect of "static" and for that reason the name of "X-Stopper" was given it.

X Q. 121. I call your attention to the apparent fact that the reason that the Marconi Company in its circular to which I have called your attention directed operators not to omit the use of this "Tune A X-Stopping Device" was not on account of static but apparently on account of interference from other stations. What have you to say as to that?

A. It has been claimed by operators that when the X-Stopper was used more selective tuning was possible.

X Q. 122. But if the apparatus shown in Figs. 2 and 2 A of Plaintiff's Exhibit I (Claimant's Exhibit No. 151) were already tuned to a definite wave length, how could they be disturbed by any other wave length?

A. I think to appreciate that one must have been a wireless operator, because even though you may have a circuit tuned to a definite wave length, nevertheless if a ship very close to your station and to the ship from which you are receiving is transmitting with a great deal of power on a wave length other than that with which you are receiving, you may still get some interference, and, as I have said, it was claimed by operators that if the X-Stopper was used this interference to which I have referred could have been eliminated; further, interference stands for not only disturbances from wireless stations, but there are peculiar [fol. 1018] local interferences often caused by surrounding

mediums, and such interferences must also be taken into account.

X Q. 123. When was plain aerial apparatus finally discontinued by the Marconi Company?

A. It was not discontinued for emergency purposes, as some of this apparatus still exists.

X Q. 124. In Q. 21 you were asked to state from your experience how efficient, compared with untuned apparatus, was the so-called tuned apparatus which you described in Plaintiff's Exhibit I (Claimant's Ex. 151), and in answer to that you said that the Tune A apparatus was superior to the plain aerial for reasons which you give, and then you state that for this reason Tune A was used exclusively at Sea Gate "with the ships in its vicinity". With what stations did Sea Gate communicate while you were there?

A. With ship stations, and these are all that Sea Gate was required to communicate with.

X Q. 125. What stations did you communicate with from Sea Gate?

A. With ship stations.

X Q. 126. Only?

A. Only; that is, ship stations were the only stations with which Sea Gate exchanged traffic.

X Q. 127. Now, I ask you whether you personally, while at Sea Gate, ever communicated with any other station than ship stations?

A. To my recollection I never sent any messages from Sea Gate to any stations other than ship stations.

X Q. 128. And how far away were the ship stations when you sent to them? What was the farthest?

A. I could not be definite about that.

X Q. 129. Can you approximate it?

A. A distance varying from 80 to 90 miles or approximately 100, and, as you know, or should know, distances of wireless communication depend on many variable elements, and by elements I do not mean elements of apparatus but the human elements, *i. e.*, the operator, and also atmospheric conditions, etc.

X Q. 130. Where have you ever used plain aerial transmission apparatus and when?

A. I have used plain aerial transmission apparatus at ship stations when testing the emergency apparatus during my term of employment as inspector and chief inspector of the Marconi Company, and I believe that on several oc-

casions I used plain aerial transmission at the Marconi station at Siasconset when the main set was temporarily out of business. I also made a special test with plain aerial emergency apparatus on one of the Old Dominion Line boats, the report of such test having been given to Mr. Sammis, then my superior.

X Q. 131. Have you a copy of that report?

A. I have not got it here. I may say that the object of this test was to determine for the Department of Commerce the efficiency of the plain aerial transmitting apparatus for emergency purposes.

X Q. 132. Do you recall generally what your tests showed in this respect?

A. My tests in this respect showed that when the apparatus was properly operated and the antenna insulation was good, that the legal requirement of 100 miles could be negotiated; but since that time more improved emergency equipment has been supplied and installed on the majority of vessels carrying the Marconi system. By more improved apparatus I mean that a battery sufficiently large to operate the motor generator of the main transmitter has been installed on a very large number of vessels, so that in case of distress, when the ship's dynamo is unable to furnish current the motor generator is operated from the reserve power supplied by the batteries. The Marconi Company [fol. 1019] has, during the past year, removed, I should say, approximately about 175 to 200 induction coil emergency equipment, the shipping companies supplying the batteries for operation of the main set instead.

X Q. 133. Are the batteries which you are now supplying for your emergency sets more powerful than those you previously supplied for use with the induction coil plain aerial apparatus?

A. They are. In the former case the batteries consisted of 12 cells giving a voltage varying from 24 to 26, while the present batteries being supplied by the shipping companies for the operation of the Marconi main set give a voltage of about 120.

X Q. 134. Now, with the motor generator sets using this battery giving a voltage of 120, you are able to negotiate the required 100 mile distance specified by the Department of Commerce regulations, are you?

A. Yes, and more.

X Q. 135. How much more?

A. Depending, as I have said, on the variable elements, but the main sets which we have recently installed on a large number of vessels and which operate from the batteries have covered distances varying from 200 to 2,000 miles.

X Q. 136. What is the greatest distance that has been covered with plain aerial apparatus using the batteries which give approximately 25 volts?

A. I don't know definitely.

X Q. 137. In what year did you make these tests to which you referred a little while ago, for the Department of Commerce?

A. I believe in 1912; about the middle of that year.

X Q. 138. Now, when you made these 1912 tests, did you make any comparative tests of the apparatus on the ships, that is to say, did you compare the plain aerial apparatus with any coupled circuit apparatus which the ship might have had?

A. I did.

X Q. 139. What did those tests consist of generally?

A. Those tests consisted of sending and receiving signals with plain aerial and also sending and receiving signals with the tuned apparatus on board the ship.

X Q. 140. Did you use the same power in connection with the plain aerial apparatus as with the tuned apparatus?

A. No.

X Q. 141. What was the difference between the two?

A. I should say that the power used with the plain aerial apparatus was about 400 or 500 watts, while the power used with the tuned apparatus was 1,000 watts.

X Q. 142. Did you talk with the same station first with one kind of apparatus, that is to say, the plain aerial transmitter and then with the coupled circuit or tuned transmitter, and, if so, what were the apparent results so far as the distances reached efficiently was concerned?

A. I did, and in some cases it was necessary in order to obtain the attention of the station called to first use the tuned coupled apparatus, advise the operator of the test. I desired to conduct, and next use the plain aerial apparatus. There were instances where the station called could not hear the plain aerial while it could very efficiently hear the signals sent from the tuned coupled transmitter.

X Q. 143. How far away were these stations from the ship at the time you sent the messages?

A. The distances varied, in some cases being almost abeam of the radio station up to approximately 300 miles.

X Q. 144. The stations I want to include in my last question were those which you could not raise with the plain [fol. 1020] aerial but could with the tuned apparatus, and what distances were they and what specific instances were they?

A. The specific instance that comes to my mind at this time is the Marconi station at Sagaponack, Long Island.

X Q. 145. How far from the ship was it at that time?

A. I believe about 250 miles, but I could not be more definite as to the distance.

X Q. 146. Was there any instance where the reverse conditions were true, that is, where you could raise the distant station with the plain aerial but could not with the tuned transmitter?

A. There was not.

X Q. 147. Did you first try to get into communication with these test stations always with the plain aerial?

A. I did.

X Q. 148. Will you produce a copy of that report?

A. If it has not been destroyed I will be glad to produce it and I will make a search for it.

X Q. 149. Am I correct in understanding that the receiving apparatus shown in Fig. 4 was variable as to inductance and capacity in the closed oscillating circuits and variable as to inductance at least in the aerial circuit?

A. Your understanding is correct.

X Q. 150. When did this receiving apparatus come into use?

A. I believe in 1908 in this country.

X Q. 151. Was that the first use, so far as you know, by the Marconi Company in this country of coupled circuit receiving apparatus in which the resonance of the circuits was under the control of the operator?

A. No.

X Q. 152. What prior apparatus of that character was used in this country by the Marconi Company?

A. Individual inductance coils or loading coils and ball condensers were supplied at ship and shore stations, and these were used with the magnetic detector and the operators could tune accordingly.

X Q. 153. Were there individual loading coils and billi condensers variable?

A. They were.

X Q. 154. And were they both used in the antenna circuit?

A. That was a matter of preference; as various hook-ups were used, but the preferred practice was, of course, the apparatus described in Fig. 4, and about the time to which I have referred the loading coils and billi condensers were being replaced with the multiple tuners.

X Q. 155. When did these auxiliary loading coils and billi condensers first come into use, so far as you know?

A. So far as I know, they were in use in 1907.

X Q. 156. My understanding of your testimony is that you are informed that it was the practice of the Marconi engineers to specially construct the antenna circuit of the apparatus shown in Fig. 1 of Plaintiff's Exhibit I (Claimant's Ex. No. 151), so that with a fixed inductance d' therein that circuit would be in tune with the closed oscillatory circuit, having fixed capacity and fixed inductance as shown in Fig. 1. Is that correct?

A. Your understanding is correct, with one exception: that in the case of Fig. 1 the leads from the spark gap G to the primary of the jigger or oscillation transformer d and the leads from the other side of the spark gap G to the condenser e and the leads from the other side of the condenser e to the remaining side of the primary of the jigger or oscillation transformer d could be varied as to its length, and it is my understanding that this was done at the time the installation was made.

X Q. 157. Is there any engineer or other qualified person [fol. 1021] now connected with the Marconi Company, so far as you know, who has direct personal knowledge of the method of constructing the antenna as described in your answer to Q. 23 and of varying the closed oscillatory circuit of Fig. 1 in the manner to which you have just referred?

A. I believe that Mr. A. H. Ginman, previously mentioned, is the man possessing such knowledge.

X Q. 158. Is he the only one?

A. So far as I know, at this moment.

X Q. 159. Have you been able to find, during recess, the report of the tests from the Old Dominion Line steamer about which you testified this morning?

A. I have not.

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Redirect examination.

By Mr. Peters:

R. D. Q. 160. I believe you stated on cross-examination that you never saw the circuit of Fig. 1 of your drawing, Plaintiff's Exhibit I (Claimant's Exhibit No. 151), operated with anything except six condenser jars. Will you explain what you meant a little more fully?

A. I meant by that statement that when Tune A was used only six jars comprised the condenser *c* of the closed oscillatory circuit, but when the apparatus shown in Fig. 1 was operating on Tune B, the condenser *c* was increased to a number of jars varying from twelve to sixteen, the exact number depending upon the period of the open radiating circuit.

R. D. Q. 161. You stated that you don't know when Plaintiff's Exhibit J (Claimant's Exhibit No. 152) was published. State from your recollection the best you can when you first saw catalogues of this kind in the possession of the American Marconi Company.

A. It is my recollection that I first saw catalogues of the nature described about 1908, when the multiple tuner was being placed in service. It was the custom of the Marconi Company to send instructions for operation of the multiple tuner with the instrument.

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Deposition closed.

Deposition of JOHN BOTTOMLEY, for claimant, taken at New York, N. Y., on the 13th day of March, A. D. 1916.

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Direct examination.

By Mr. Peters:

Q. 1. Please state your name, age, residence and occupation.

A. John Bottomley; age 68; residence 112 East 55th Street, New York City; occupation, vice president, secre-

tary and treasurer of the Marconi Wireless Telegraph Company of America and member of the board of directors and executive committee of the same company.

Q. 2. How long have you been connected with the American [fol. 1922] Marconi Company and its affiliated company, the British Company, and in what capacities? Just give a brief resume.

A. In 1901, or, possibly, 1900, I was acting for the English Marconi Company, who were doing certain work out here, and in 1902 I joined the Marconi Wireless Telegraph Company of America when it was reorganized in April, 1902, and have continued with the Marconi Wireless Telegraph Company of America ever since in various capacities, first as temporary manager, secondly as treasurer and secretary, third as general manager, treasurer and secretary, and up to to-day, when I am as I described above.

Q. 3. Prior to 1908, in what capacity was Mr. F. M. Sammis employed by the Marconi Company?

A. He was stock clerk and superintendent of a little shop we had in which little parts of apparatus were put together.

Q. 4. And prior to 1908 who had active charge of the executive affairs of the Company?

A. The executive? I had.

Q. 5. And who had charge of the engineering matters?

A. William W. Bradfield was elected resident engineer in 1902 and continued until 1908, when he left this country for England.

Q. 6. Where is Mr. Bradfield now?

A. He is in England, London, England, connected with the Marconi Wireless Telegraph Company, Limited.

Q. 7. What general types of apparatus were employed by the Marconi Company in this country prior to 1908?

A. Chiefly tuned apparatus; partially plain aerial.

Q. 8. Do you remember the occasion when the Nantucket Light Ship was equipped with wireless apparatus?

A. Yes, sir; in 1901.

Q. 9. Do you recall whether or not the question came up at the time as to whether tuned or untuned apparatus should be used?

A. The question came up and it was decided that tuned apparatus should be used.

Q. 10. In what way did the question come up?

A. In general consultation as to the best method by which signals could be sent.

Q. 11. From 1901 on what did your engineers and those in charge of the operation report to you as to the character of apparatus being used?

A. They reported to me that they were using tuned apparatus.

Q. 12. I show you Plaintiff's Exhibit M, Circular No. 37 (Claimant's Ex. No. 155). Please state, if you can, what this is.

A. This is a circular which was issued to various ships and all stations from our office showing the form of apparatus which is employed upon the stations which we had equipped and also which were to communicate with our stations.

Q. 13. What did you have to do with the issuing of this circular?

A. I was in consultation with Mr. W. W. Bradfield, who not only acted as engineer but also as semi-traffic manager in those days and he and I ascertained what apparatus was being used on the various stations and embodied it in the form of this circular. We also had information from England and other points as to what their ships were equipped with and this was embodied in the circular also.

Q. 14. In connection with each station listed as an American [fol. 1023] can Marconi station, and under the heading "Appar" there appear the letters "TA." State, if you can, what these letters mean.

A. "TA" represented Tune A, one of the forms of tuning.

Q. 15. What was the object in issuing this circular to each station calling attention to the type and character of apparatus used at the other stations?

A. So that each ship, as it approached the station, could prepare itself to use the Tune A, some of them having installed, besides the Tune A, plain aerial, and to notify each station of what we were prepared to communicate with or from.

Q. 16. Would it be correct to say that Mr. Sammis joined the Marconi Company as assistant chief engineer?

A. It would not.

Q. 17. Did he represent himself as being a wireless engineer when he joined the Company?

A. He did not.

Q. 18. To what extent, if at all, prior to 1908, did Mr. Sammis act as a wireless engineer?

A. He did not act at all as a wireless engineer with my sanction or permission, and until 1912 he was never called engineer. At that time he was made chief engineer at the time of the reorganization.

Q. 19. Under what circumstances did Mr. Sammis leave the employ of the Marconi Company?

A. His method of conducting the business was not satisfactory to the management. The matter was discussed between Mr. Nally, our general manager, and myself; it was discussed in the executive committee, of which I am a member, and it was decided a change should be made.

Q. 20. Was this decided before or after he had offered his resignation?

A. Before. May I explain a little?

Q. 21. Yes, go ahead.

A. He was informed that a change was about to be made, and as he had been a long time in our service he was given a chance to stay with us for about three months, pending which time he might be able to procure other employment; but he immediately felt annoyed about it and said he would not stay any longer and said he would resign. His resignation was not handed in further than that, and he was requested to send his resignation; he did not do so and he was then notified that the verbal resignation was accepted.

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Cross-examination.

By Mr. Scull:

X Q. 23. Have you any personal knowledge, Mr. Bottomley, of the specific apparatus used by the Marconi Company during any period about which you have testified here?

A. What do you mean by specific knowledge?

X Q. 24. You are not an engineer, are you, Mr. Bottomley?

A. No, sir.

[fol. 1024] X Q. 25. You have never had any personal contact with the actual apparatus used by the Marconi Company?

A. I have never set it up or anything of that nature; I have seen it in the various stations.

X Q. 26. Are you familiar enough with the art to know whether an apparatus is tuned or not when you see it?

A. No, sir.

X Q. 27. When Mr. Sammis entered the employ of the Marconi Company what were his duties?

A. Stock clerk and taking charge of a small shop we had which was then in Bridge Street.

X Q. 28. Who had direct charge of that shop?

A. Mr. Bradfield.

X Q. 29. Then, was Mr. Sammis connected with Mr. Bradfield's work until Mr. Bradfield left the Marconi Company?

A. He was working under Mr. Bradfield, yes.

X Q. 30. Would it be proper to speak of him as an assistant to Mr. Bradfield?

A. I should not say so.

X Q. 31. Whom was he an assistant to?

A. He hadn't any. Mr. Bradfield, you say?

X Q. 32. No; who was Mr. Sammis an assistant to?

A. Nobody; a storekeeper is not an assistant.

X Q. 33. But he was working under Mr. Bradfield's direction?

A. Yes, sir.

X Q. 34. And he was wholly connected with the engineering end of the Marconi Company's business, was he not?

A. Yes, sir.—I hesitated when I answered that, because I suppose you call that the engineering end.

X Q. 35. I thought you said in your direct examination that you received reports from the engineers of the Company as to the kind of apparatus that was being used? Am I correct?

A. They consulted me as to the kind of apparatus that was being used, yes.

X Q. 36. In what form does these reports come to you?

A. Verbal reports; conversations.

X Q. 37. Not in writing?

A. No, sir.

X Q. 38. Is there any employe now connected with the Marconi Company of America who has knowledge of the apparatus used by that Company prior to 1907?

A. I should say there are several, not to say many; as to their knowledge I could not tell you.

X Q. 39. Who are they?

A. Mr. Weaver, Mr. Edwards, I think Mr. Sarnoff—I am not sure whether he was there prior to 1907—Mr. Ward,

and undoubtedly there are others, but I don't recall their names at this moment.

X Q. 40. Where is Mr. Weaver located now?

A. Sea Gate.

X Q. 41. That is in New York City, is it not?

A. Yes, sir.

X Q. 42. Where is Mr. Edwards located?

A. New York City.

X Q. 43. Prior to 1908, was the apparatus used by the Marconi Company of America determined in any way by the British Marconi Company?

A. A portion of it was sent out from England and installed here and their advice was taken; but they did not control or determine anything.

X Q. 44. Was the Marconi Company of America guided in the kind of apparatus it used by the advice of the British Marconi Company prior to 1908?

A. To the extent of making the apparatus uniform on all stations.

X Q. 45. That is to say, the apparatus used by the Marconi Company of America was uniform with that used by the British Marconi Company. Is that true?

A. Yes, sir.

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Redirect examination.

By Mr. Peters:

R. D. Q. 46. Was Mr. Ginman connected with the Marconi Company prior to 1908?

A. Yes, sir; Albert H. Ginman.

R. D. Q. 47. For how long a period?

A. I think since 1903 or 1904.

Deposition closed.

New York, March 14, 1916, 3 P. M.

Deposition of John W. Griggs, for claimant, taken at New York, N. Y., on the 14th day of March, A. D. 1916

Direct examination.

By Mr. Peters:

Q. 1. Please state your name, residence and occupation.

A. My name is John W. Griggs, I reside at Paterson,

New Jersey; I am a member of the Bar and also am president of the Marconi Wireless Company of America.

Q. 2. What public offices have you held?

A. I was a member of the House of Assembly of the New Jersey Legislature in 1876 and 1877; I was a member of the New Jersey Senate from 1883 to 1889; I was Governor of New Jersey from 1896 to 1898; I was Attorney General of the United States from 1898 to April 1, 1901, and I was for ten years a member of the Hague Arbitration Tribunal.

Q. 3. How long have you been president of the Marconi Company?

A. I think since 1903.

Q. 4. And prior to that time had you been connected with the Company?

A. As a director, yes.

Q. 5. For how long?

A. Since 1902; I think it was in 1902 I became a director.

Q. 6. What in the past has been the condition of the wireless telegraph business in this country as affecting the necessity or expediency of prosecuting for patent infringement? Please give a brief history of the business in this country and the efforts by the Marconi Company to protect its patent rights.

A. Beginning with 1902, when my first knowledge of it was acquired, the art was in a formative state, so far as this country went, at least; there was nobody engaged in wireless operations except the Marconi Company and Mr. Marconi. They, endeavoring to establish a commercial business, undertook first the establishment of shore stations and the equipment of American ships crossing the Atlantic for the purpose of developing what is called a ship to shore business; that is, receiving messages from steamships at the shore stations and transmitting messages from the shore stations to the ships at sea. The American Marconi Company was limited in its equipment to American ships, [fol. 1026] of which, down to 1904, I think there were only four in commission, that is the four ships of the American Line; I think two others were added about that time, two Dutch ships. During this time the United States Government began to equip naval vessels and, I think, revenue cutters with wireless apparatus, and the Marconi Company supplied various apparatus to the Government and made that a part of its business.

The first indication of any competitive operation by an infringer was that of the De Forest Wireless Telegraph Company, which was a company organized by Dr. De Forest. We promptly began suit against them in 1902, and the case was decided against them by Judge Townsend, of the United States Circuit Court for the Southern District of New York in 1905, in a decision that is reported in 138 Federal Reporter 657. I made use of that decision in an effort to prevent the United States Government from purchasing apparatus of De Forest, or his Company. We had protested to the Government before that suit was decided. After it was decided I saw Admiral Manney, who was in charge of the Bureau of Construction of the Navy Department, and informed him that we had a decree adjudicating the patent rights in the Marconi Company and that we did not want them to deal any further with the De Forest Company. Admiral Manney said that the Navy Department did not recognize a decree in a patent suit rendered by an inferior Court as authoritative, and it was only when it was decided by the Circuit Court of Appeals or the United States Supreme Court that they recognized it. I replied that in this case the defendant had failed to take an appeal and we had got the decree of the last and only court that could decide it. Admiral Manney said that that did not make any difference to them, it was still an inferior court. The De Forest Wireless Telegraph Company became insolvent, so it was never worth while to have an accounting under our decree.

Then De Forest formed several companies, all for the purpose of exploiting wireless apparatus which we claimed to be infringements on the Marconi patents, and we began another suit against one of the new brood of De Forest Companies and applied for an injunction. De Forest came in and set up a lot of facts and evidence which had not been before Judge Townsend and we failed to get a preliminary injunction, but we never went on with the case because that Company was afterwards absorbed in the United Wireless Telegraph Company.

The United Wireless Telegraph Company was, I think I am justified in saying, a stock jobbing operation. Its president, Christopher Columbus Wilson, was indicted for fraud in sending through the mails circulars relative to the stock of this Company, was convicted and served a term in prison; I think he died in prison. Meantime, in 1909, we

began a suit for infringement against this same United Wireless Company, which was subsequently terminated after the bankruptcy and dissolution of the United Wireless by a decree adjudicating infringement, which, however, was taken by consent.

The next infringement that was brought to our notice was the National Electrical Signalling Company of Pittsburgh. We began suit against that in May, 1912, and a decision against them was made by Judge Veeder on March 17, 1914, which is reported in 213 Federal Reporter at page 815, and a final decree was entered on that opinion April 6, 1914. During all this time, from 1902 to 1914, the Marconi [fol. 1027] Company had been improving its apparatus, expanding its business, equipping more and more ships, supplying more and more apparatus, and the competition that we found from infringement came, as I have said, first from the De Forests, then from another De Forest Company, then from the United Wireless, which was a combination of the De Forest enterprises, then from the National Electrical Signalling Company. Now, the National Electrical Signalling Company down to the time that we began suit against them we had hardly known to be engaged in any commercial business. Their expert and inventor was Mr. Fessenden, and we knew that he had a plant at Brant Rock, Massachusetts, where he conducted experiments, but it was not until we found that they were bidding for the supply of apparatus to the Navy Department and for the construction of a high power station at Arlington, Virginia, for the Government that they became apparent as competitors and infringers, and then we began suit against them.

Later on, in 1914, we found that the Atlantic Communication Company was carrying on business with Germany and using the Marconi patent and suit was begun against that Company on April 24, 1914. Then, in 1914, Dr. De Forest developed another company, which he called the De Forest Radio Telephone Company, and believing that to be an infringer, we began suit against that in October, 1914, and that suit is still pending. The suit against the Atlantic Communication Company was partially tried and the taking of evidence was suspended, as I recollect, because Mr. Marconi, who was testifying, was called into the service of Italy by the declaration of war which his Government, Italy, made against Austria. And I may say, generally, that the Company has promptly challenged every infring-

ing operation of a commercial kind that it has had any evidence of from 1902 down to the present time.

Q. 7. Which of the suits you have referred to were based on the patents in suit, namely, Lodge patent 609,154 and Marconi patent 763,772?

A. The suit against the United Wireless Company, commenced May 6, 1909, was on the Marconi tuning patent 763,772; the suit against the De Forest Wireless Telegraph Company commenced in 1902 was on the Marconi reissue patent No. 11,913; the suits against the National Electric Signalling Company were on the tuning patent, commonly called the "four sevens" and the other one you have mentioned I have not got the number here. The suit against the Atlantic Communication Company is on the tuning patent as I understand it.

Q. 8. Please state whether or not you obtained an injunction against the Atlantic Communication Company and whether or not it is still in force.

A. Yes; a preliminary injunction, which is still in force.

Q. 9. Do you recall a company known as the Radio Telephone Company? If so, state what its activities were and its history, so far as you know it.

A. I don't recall that as distinguished from the De Forest Radio Telephone Company. I think that the two patents involved in the National Electrical Signalling Company suit were for easy phrasing, called the "Lodge Patent," and the tuning patent; that is my recollection.

Q. 10. Do you recall a suit brought by the Marconi Company against the De Forest Radio Telephone and Tele- [fol. 1028] graph Company and the Standard Oil Company?

A. There was a suit brought in which the Standard Oil Company was involved as the user of infringing apparatus; I don't recall what corporation was defendant with them, if any.

Q. 11. What proceedings were had, so far as you know, in that suit?

A. An injunction was obtained, so we were advised, and the Standard Oil Company ceased using the infringing apparatus and obtained, as licensee apparatus from the Marconi Company to supplant it. I recall another suit now; that is one brought against a man by the name of Simon, who had obtained an order from the Navy Department to supply seventeen or more apparatus for sub-

marines. Simon set up that he was doing this for the Navy Department, and Judge Hough held that that being so, we could neither have an injunction against him, nor was he an infringer liable to account, although the pleadings admitted that he was an infringer. That case was appealed by our Company.

Q. 12. Did the Marconi Company have any knowledge at any time between 1900 and 1910 of any commercial activities on the part of the concern called the Stone Telephone and Telegraph Company?

A. It never came to the notice of the officers of the Company or Board of the Executive Committee. In fact, it was only very recently that I ever heard of a Company by that name.

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Cross-examination.

By Mr. Scull:

X Q. 13. On what patent was this suit against the United Wireless Company in 1909 brought?

A. My recollection is that it was brought on the tuning patent and on the Lodge patent; but I am not sure about the latter.

X Q. 14. What became of that suit?

A. A decree admitting infringement was taken by consent.

X Q. 15. In that suit against the National Electrical Signalling Company in the Eastern District of New York, what patents were involved?

A. The patent known as the Lodge patent which this Company acquired from Sir Oliver Lodge and the Marconi tuning patent.

X Q. 16. Any other?

A. Not that I recollect.

X Q. 17. Do you know whether or not Reissue Patent 11,913 was also involved in that suit?

A. I can't remember, no.

X Q. 18. You have said that the suit against the Atlantic Communication Company on the two patents here in suit was, as I understand you, partially tried and then suspended because Mr. Marconi had to go to Italy. Was not his testimony available in that suit so that it could have been continued?

A. I think not.

X Q. 19. Do you know that a commission to take his testimony in the present case has been issued?

A. I am so informed, but I was also informed that there was some mistake about its having been sent forward.

X Q. 20. So far as you know, was any endeavor made to take Mr. Marconi's testimony in a similar way in the suit against the Atlantic Communication Company?

A. No.

X Q. 21. In the suit in the Eastern District of New York against the National Electrical Signalling Company no appeal was taken by the defendant, was there?

A. Yes; an appeal was taken.

X Q. 22. Was that appeal ever argued?

A. No.

X. Q. 23. Do you know any reason why it was not?

A. Yes.

X Q. 24. What was that?

[fol. 1029] A. Because the National Electrical Signalling Company abandoned the appeal and took a license from the Marconi Company.

X Q. 25. Had the National Electrical Signalling Company obtained an injunction against the Marconi Company on some of its patents?

A. Yes, on what is called the high frequency patent.

X Q. 26. And did the Marconi Company take a license from the National Electrical Signalling Company under that patent?

A. It did.

X Q. 27. What was the first suit brought on the Marconi patent here in suit, the so-called "tuning patent," by the Marconi Company and when?

A. As far as I know the first suit was the one against the United Wireless Company commenced in 1909.

X Q. 28. Were any of the De Forest Companies, prior to 1909, so far as you know, infringing that patent?

A. They must have been or we would not have brought suit against them in 1909.

X Q. 29. When did you first know that the De Forest Company was infringing that patent?

A. That I cannot tell you.

X Q. 30. That Company was the predecessor of the United Wireless Company, so far as you know?

A. I think there were two or three different De Forest Companies having the word "De Forest" in the name of

the corporation, but each one of them being varied in some kind of a way.

X Q. 31. Were any of these De Forest Companies active commercially?

A. Only to a very limited extent in supplying apparatus to the Government.

X Q. 32. Did not the American De Forest Wireless Company have stations on the Coast and throughout the country prior to 1909?

A. They might have had a few so-called stations, but my recollection is that the most of the stations used subsequently by the United Wireless were built under the auspices of the United Wireless, and they undoubtedly showed a good deal of activity in putting up stations, but when the title in those stations passed subsequently to the Marconi Company we found that as a rule, they were very shabby institutions; in several instances they had no title whatever to the land on which they were built.

X Q. 33. Did not the American De Forest Company equip a number of ships, particularly on the Great Lakes, prior to 1909?

A. I think they did, some.

X Q. 34. Did the Marconi Company have any ships equipped on the Great Lakes with its apparatus prior to 1909?

A. I cannot answer that; I don't remember.

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Redirect examination.

By Mr. Peters:

R. D. Q. 35. What can you say as to whether or not the De Forest Companies prior to 1912, and any other companies engaged in commercial work prior to that time, were engaged in legitimate commercial work as distinguished from erecting stations for stock jobbing purposes?

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A. In my opinion, from what I know of the attempts of the De Forest Companies and the United Wireless Company [fol. 1030] to sell their stock to the public and the success with which they sold it and the subsequent disclosure of the fact that their entire material organization was nothing but a shell, the latter fact having come to my knowledge

as an officer of the Company when we acquired their material property,—from those facts I think I am justified in saying that their operations were only carried on to a sufficient extent to impress the public with the belief that they were a genuine commercial enterprise likely to become profitable to stockholders, and that there was no bona fide attempt to establish a real commercial enterprise that would be profitable to stockholders; in other words, I think they were what are known as stock-jobbing companies.

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Recross-examination.

By Mr. Scull:

R. X Q. 36. The assets of the United Wireless Company were bought by the Marconi Company, were they not?

A. Yes; the physical assets.

R. X Q. 37. In what year?

A. Why, I think it was 1912; I am not quite sure of these years.

R. X Q. 38. At the time the Marconi Company took over the physical assets of the United Wireless Company did it not also take over operating contracts with ship stations which the United Wireless Company had?

A. Just whether it took over the contracts and assumed them or not I cannot say, but at any rate it took over the apparatus that were on the ships that the United Wireless had equipped.

R. X Q. 39. And did it not continue to operate that apparatus for the ships?

A. Generally speaking, I think yes, but I think that other apparatus was substituted as soon as it conveniently could be.

R. X Q. 40. How many of such ship stations were taken over by the Marconi Company from the United Wireless Company when the former bought the assets of the United Wireless Company?

A. I cannot tell you from recollection; I have nothing here to refer to that would show me.

R. X Q. 41. Well, do you know whether or not at that time the United Wireless Company had equipped more ships that had, up to that time, been equipped by the Marconi Company of America?

A. I think they had, but they were not Atlantic liners; they were coasting ships, or on the Great Lakes; I am not sure which.

R. X Q. 42. So that this stock jobbing company had, as a matter of fact, put out more apparatus at the time you took over its assets than the Marconi Company had, is that true?

A. Well, I could not tell you because I have not the data here, but they had put out a considerable amount, on all of which they were losing money.

R. X Q. 43. But, I ask you, Governor, what the relation between the number of stations equipped by the United Company was as compared with the number equipped up to that time by the Marconi Company?

A. All I can say is that my recollection is, and it would be subject to correction by looking at the figures, that there were more ships of all kinds that were equipped with the United Wireless apparatus than were equipped with Marconi apparatus.

Deposition Closed.

[fol. 1031] *Deposition of Albert Ginman, for claimant, taken at New York, N. Y., on the 14th day of March, A. D. 1916.*

Mr. Betts:

Q. State your name.

A. Albert Ginman.

Q. What is your occupation, Mr. Ginman?

A. General superintendent, Pacific Coast division, Marconi Wireless Telegraph Company.

Q. How long have you occupied that position?

A. Since the fall of 1911.

Q. What territory is included within the Pacific Coast division of the Marconi Company?

A. All the Coast line of the Pacific Coast of the United States, and the territory of Alaska, and Hawaii.

Q. Where are your offices located?

A. The division offices are in San Francisco. The district office of the Northern district is in Seattle, from which the territory from Oregon north is served.

Q. What is the character of the business conducted by the plaintiff Marconi Company?

A. The manufacture of wireless telegraph apparatus, its sale to the various departments of the United States government, to railroads, to the owners of private yachts, and to individuals or corporations who desire to erect stations for their semi-commercial purposes. We also lease wireless equipments to owners of vessels in the maritime service. A general telegraph service is also conducted between ship and shore stations, likewise a trans-oceanic service between Honolulu and San Francisco. We also conduct a general telegraph service between points in Alaska, Seattle and Astoria, Oregon.

Q. In your last answer you referred to some shore stations; what is the purpose of having these shore stations, and about how many are maintained by the plaintiff company?

A. You refer now to shore stations in the marine service, Mr. Betts?

Q. In the marine service.

A. I cannot tell the exact number of shore stations in the marine service throughout the entire organization, but they extend on the Atlantic Coast from Boston to Galveston, and there is quite a chain on the Great Lakes. But on the Pacific Coast I can tell the number and their location.

Q. Well, will you please refer to the map, Plaintiff's Exhibit 30 (Marconi v. Kilbourne & Clark), and point out to the court where the shore stations for marine service are located.

A. (Indicating to the court on map.) All the shore stations on the Pacific Coast are marked in red ink, one being at Juneau, in Alaska, one at Ketchikan, in Alaska, one at Seattle, Washington, one at Astoria, Oregon, one at Marshfield, Oregon, one at Eureka, California, one at San Francisco, California, one at San Pedro, California, and another at Avalon, on Catalina Island, California—nine stations, altogether.

Q. On the Pacific Coast?

A. On the Pacific Coast.

Q. What is the character of the apparatus used in these shore stations?

A. Coupled tuned circuits.

Q. With what ships are the Marconi land or shore stations required to communicate?

A. With all ships, regardless of the flag carried or the system of wireless telegraphy used.

Q. Why are they required to communicate with all ships? [fol. 1032] A. That is the United States government regulation, and I believe it is also required by International law.

Q. State, if you know, approximately what is the amount of investment involved in the erection and equipment of the land Marconi stations on the Pacific Coast, and the cost of maintaining them?

A. The cost of investment is approximately two million dollars, and the cost of operating those stations about \$180,000 per annum. But those figures include not only stations in the marine service, but also in the trans-Pacific and Alaskan service. The investment charges against the marine stations of the Pacific Coast is approximately seventy thousand dollars, and the annual cost of operating those stations about nineteen thousand dollars.

Q. Are the marine stations on the Pacific Coast of the plaintiff company operated at a loss or a profit?

A. At a loss of about nine thousand dollars per annum.

Q. Why does the plaintiff company maintain these land stations in operation?

A. Because under our contract with ship owners we agreed to provide a free telegraph service within certain limits, and the chain of shore stations is necessary to maintain that service.

Mr. Betts: You may cross examine.

Cross-examination.

Mr. Farnsworth:

Q. Did you, as head of the Pacific Division of the Marconi Company, ever ask leave of any officer of the defendant to inspect defendant's apparatus?

A. No, sir.

Q. Not prior to the commencement of this suit last August?

A. No, sir.

Q. Not prior to the commencement of this trial in March last?

A. No, sir.

Q. Are there any government land stations operating in commercial business in the Pacific Division of the Marconi Company?

A. There are.

Q. How many?

A. I could not say the number that are open for commercial business.

Q. Approximately, in your division?

A. But I know there is one at Point Loma, and there is one at San Francisco, or, rather, Mare Island, but I am not sure that there are any others.

Q. How many leased sets of radio apparatus has the Marconi Company in your division?

A. Ninety-eight at present.

Q. How many Marconi sets are sold outright in your division?

A. That have been sold since 1911?

Q. Yes.

A. That I could not say.

Q. Do your Marconi stations in your jurisdiction here charge regular rates for transmission and receipt of commercial messages?

A. Yes, sir.

Q. The land stations do?

A. Yes, sir.

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[fol. 1033] *Deposition of C. H. Taylor, for claimant, taken at New York, N. Y., on the 14th day of April, A. D. 1916*

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Mr. Betts:

Q. What is your occupation, Mr. Taylor?

A. A radio engineer.

Q. Have you ever testified in court before?

A. No, sir.

Q. You have never testified before?

A. No, sir.

Q. Where have you recently been?

A. I have just returned from Honolulu.

Q. What was the purpose of your being in Honolulu?

A. I was there for the purpose of conducting some tests from Honolulu to a wireless station built by the Japanese government.

Q. In whose employ are you at present?

A. I am in the employ of the Marconi's Wireless Telegraph Company, Limited.

Q. How long have you been in this country this time?

A. Since October of 1912.

Q. And why were you sent to this country in 1912?

A. For the purpose of installing and erecting the long distance high-power stations to be built by the American Marconi Company.

Q. What long distance or high-powered stations do you refer to?

A. I refer to the Honolulu station, from which I have just returned, which was to work to the Japanese government station, and to the station erected in California by the American Company, that California station, and the station erected in New Jersey to work to England, and a station erected in Massachusetts to work with the station to be erected by the Norwegian government in Norway.

Q. And you have been in charge of the erection and installation of apparatus on these American high-powered stations?

A. Yes, sir.

Q. Are the Honolulu and San Francisco stations completed?

A. The stations to work from Honolulu to San Francisco are complete and operating.

Q. What is the distance between those stations?

A. So far as I can remember, it is about twenty-three hundred miles.

Q. They are in daily communication, or intermittently?

A. They are in daily communication.

Q. Carrying on commercial traffic?

A. Carrying on commercial business, yes.

Q. Were you ever in the employ of the American Marconi Company?

A. Yes, I was in the employ of the American Marconi Company from 1902 to 1909.

Q. When first in 1902 did you enter the employ of the American Marconi Company?

A. In August, 1902.

Q. You came from where?

A. I came from London.

[fol. 1034] Q. On what ship?

A. On the "S.S. Minnetonka".

Q. And what was your purpose of coming to New York at that time?

A. My purpose was to endeavor to join the American Marconi Company, that company having just been formed.

Q. Had you had any previous experience in wireless telegraphy before that time?

A. Yes, I had joined the English Marconi Company in 1899, but I had left them in 1901.

Q. Can you describe the wireless apparatus on the Steamship "Minnetonka", on which you came over, in August, 1902?

A. The "S.S. Minnetonka" was fitted with tuned apparatus that we called Tune A. In the transmitting circuit there was a spark-gap, inductance and capacity, and in the receiver they had a tuned oscillation transformer connecting the coherer circuit with the antenna.

Q. Have you prepared and will you produce a diagram showing the Tune A apparatus to which you have referred?

A. Yes, sir (reproduced opposite). That is the Tune A transmitting apparatus and that is the Tune A receiving apparatus (producing).

Q. Well, just give the court a copy, will you?

A. (Witness handed copy to the court.)

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Q. Have him make his explanations so that the reporters get them as to each one of the figures.

A. Figure 1 is the tuned transmitter, with Tune A transmitting jigger.

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(Blue print referred to was marked Plaintiff's Exhibit "27, T-1".) (Claimant's Ex. #157.)

Q. Now, Mr. Taylor, proceed and describe the transmitting Tune A. I will have you describe, Mr. Taylor, the Fig. 1, the transmitting Tune A apparatus.

A. The oscillation transformer used with the Tune A apparatus comprises a secondary of fifteen turns and a primary of less than one turn. This secondary was wound on a square former and the primary was wound around

three sides of it and the connections brought out on the fourth, but it did not make one complete turn. The capacity used in conjunction with this primary consisted of a tray containing six Leyden jars. The total capacity of that was approximately .002.

Q. Now, how is the capacity, which you have said was six Leyden jars, illustrated on Fig. 1?

A. The capacity is shown there by two parallel lines.

The Court:

Q. What letter do you mean, what letter designates it?

A. There is no designation against it.

Mr. Betts:

Q. Well, will you put some letter, say e?

A. It is designated in Figure 1 by the letter e.

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[fol. 1035] Mr. Betts:

Q. Now, you have spoken of the primary, Mr. Taylor, in the Tune A transmitter, as being of less than a turn. How is that primary shown in Figure 1?

A. It is shown there as a single loop.

Q. I mean what is the letter?

A. I have not got a blue print of that, Mr. Betts.

(Blue print handed witness.)

A. Thank you. It is shown by the loop marked "d" in Figure 1.

Q. And the secondary of the Tune A transmitter is indicated in Fig. 1 by what letter?

A. By the letter d¹.

Q. d¹. And how many turns were in the secondary of the Tune A apparatus?

A. There were fifteen turns.

Q. Now, will you describe the receiving apparatus used on the Steamship "Minnetonka", and produce any drawing illustrating it?

A. I have already shown the drawing.

Q. That is marked how?

(Handing blue print to witness.)

A. The drawing showing the receiving apparatus on board the "Minnetonka" is shown in Figure 2. This comprises an antenna circuit f , a variable capacity, marked h , in the antenna circuit, and the primary of the oscillation transformer, marked d^1 . The secondary of the oscillation transformer is marked s^1 , with a fixed condenser $j s$.

Q. What is the element marked T in your Fig. 2?

A. T is the coherer.

Q. What are the elements marked s^1 in your Figure 2?

A. The element marked s^1 is the secondary coil of the oscillation transformer.

Q. What is the element marked $j s$ in Fig. 2?

A. The element marked $j s$ is the fixed condenser used in connection with the oscillation transformer.

Q. Were there any means by which an operator could adjust either the capacity or the inductance of the detector circuit in the Tune A receiving apparatus?

A. No, sir.

Q. What is illustrated in d^1 in Fig. 2?

A. d^1 in Fig. 2 is the primary inductance used in the antenna circuit.

Q. And what is h in Fig. 2?

A. h is the variable condenser in the antenna circuit.

Q. What is the purpose of variable condenser h ?

A. The purpose of the variable condenser h is to vary or tune the antenna circuit to the fixed secondary circuit containing the coherer.

Q. Now, referring back to your Figure 1, marked "Tuned Transmitter with Tune A transmitting jigger," was there any apparatus in the antenna circuit which was adjustable by the operator, on the "Minnetonka"?

A. No, there were no adjustments made in the antenna circuit on the "Minnetonka".

Q. Was there any adjustment of the spark circuit on the "Minnetonka", of the Tune A apparatus, by the operator?

A. There was nothing provided by which that circuit could be varied.

Q. What does the letter g in Fig. 1 indicate?

A. g indicates the spark-gap.

[fol. 1036] Q. What kind of a spark-gap was used on the "Minnetonka"?

A. A stationary type, comprising two brass balls.

Q. What does s indicate on Fig. 1?

A. s indicates a ten-inch induction coil.

Q. Was the Tune A transmitting and receiving apparatus illustrated in Figs. 1 and 2, which you have referred to, the only wireless apparatus on the "Minnetonka"?

A. Yes, that was the only apparatus supplied to the "Minnetonka" while I was on board.

Mr. Betts: I offer in evidence Fig. 2, referred to by the witness, and ask that it be marked plaintiff's exhibit.

(Paper referred to was marked plaintiff's exhibit "27, T-2".) (Claimant's Exhibit #158.)

Q. Now, when you arrived in New York on the "Minnetonka", what did you do?

A. After obtaining employment from the American Marconi Company, I was sent to Newport, Rhode Island.

Q. For what purpose?

A. For the purpose of installing some Tune A apparatus, which was to be used in conjunction with the combined Army and Navy maneuvers.

Q. How long did you remain at Newport?

A. Approximately a month.

Q. While at Newport, did you actually set up any wireless apparatus?

A. Yes, I set up the Tune A apparatus.

Q. For whom?

A. For the Army.

Q. And how did that tuned apparatus which you set up for the army differ from the tuned apparatus which you have already described?

A. There was no difference.

Q. After you left Newport, what next did you do?

A. I returned to New York and was sent to their station at Sagaponack, Long Island.

Q. Where is this station?

A. It is on the eastern end of Long Island, about ninety miles from New York.

Q. I will show you a map and ask you to point out to the court where that station was?

(Handing map to witness.)

A. (Witness indicates on map to court.)

A. The name is Sagaponack Station. Shown in red letters on the map.

Mr. Betts:

Q. Was the Sagaponack Station completed and operating when you arrived there?

A. Yes, sir.

Q. Will you describe the transmitting apparatus at the [fol. 1037] Sagaponack Station when you arrived there?

A. The transmitting apparatus was the Tune A apparatus recently described in regard to the "Minnetonka".

Q. How about the receiving apparatus at Sagaponack when you arrived there?

A. That was the coherer receiver, with the Tune A oscillation transformer.

Q. How long did you remain at Sagaponack at this time?

A. I remained there approximately seven months.

Q. Were you the operator there, or what?

A. I was in charge of the station and operated it.

Q. While you were at the Sagaponack station, did you use any other wireless apparatus than the Tune A transmitting and receiving apparatus which you have described?

A. Yes, we used some tuned apparatus which we called Tune B.

Q. Where did you get that apparatus from?

A. The parts of it were set down from the New York office.

Q. Of what company?

A. Of the American Marconi Company.

Q. Can you describe this Tune B apparatus?

A. The Tune B apparatus had an oscillation transformer and a battery of condensers. The value of the condensers was approximately .02 microfarad. The oscillation transformer had a secondary of nine turns wound on a square former, and a primary of one turn, comprising two wires in parallel, making just less than one turn.

Q. Now, I will show you two drawings (reproduced opposite) and ask you if they diagrammatically illustrate the Tune B transmitting and receiving apparatus which you have described? (Handing drawings to witness.)

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A. Yes, these two drawings illustrate the Tune B apparatus that I have just described.

Mr. Betts: I offer the blue prints in evidence and ask that they be marked plaintiff's exhibit "27, T-3" and "4".

Blue prints referred to were marked, respectively, plaintiff's exhibit "27, T-3", and plaintiff's exhibit "27, T-4". (Claimant's Exhibits Nos. 159, 160.)

Q. * * * Now, referring to the tuned transmitter for Tune B, will you explain to the court what d¹ was?

Q. What is j?

(Blue print handed to witness.)

A. d¹ is the secondary of the oscillation transformer, it is the secondary inductance of the oscillation transformer.

Q. How many turns did it have?

A. That had nine turns.

Q. And what is the element marked d in this exhibit?

A. d is the primary coil of the oscillation transformer.

Q. How many turns did that have?

A. That had approximately one turn, but less than one turn.

Q. What is the element not marked but indicated by a square?

A. That is the battery of condensers.

[fol. 1038] Q. Will you mark that with the letter e?

A. I mark that e. (Marking.)

Q. How many condensers were there in this battery?

A. Fifteen Leyden jars.

Q. What is the part marked g?

A. g is the spark-gap.

Q. What is the part marked s?

A. s is the ten-inch induction coil.

Q. Were there any elements of a spark-gap circuit which could be varied by the operator?

A. No variation was provided in this circuit.

Q. Were there any elements in the antenna circuit which the operator could vary or adjust?

A. No. No provision was made for varying the component parts of the antenna circuit.

Q. Now, referring to the drawing marked "Tuned Receiver for Tune B", what is d¹?

A. d¹ is the primary of the oscillation transformer.

Q. What is s¹?

A. s¹ is the secondary inductance of the oscillation transformer.

Q. What is j?

A. j is the fixed condenser.

Q. And what is T?

A. T is the coherer.

Q. What is c^2 and c^1 ?

A. c^1 and c^2 are choke coils.

Q. What is b?

A. b is the primary battery.

Q. And what is r?

A. r is the relay.

Q. Any adjustable elements in the detector circuit in Tune B apparatus?

A. No.

Q. Any adjustable elements in the antenna circuit of Tune B apparatus?

A. No, none whatever.

Q. Now, referring to the oscillation transformers at the transmitters of Tunes A and B, were they identical or were they different?

A. The oscillation transformers of Tunes A and B were different.

Q. In what way did oscillation transformers Tune B differ from those of Tune A?

A. The number of turns in the secondary, and, consequently, its inductance was different.

Q. And as to the oscillation transformers in Tune B, as contrasted with Tune A, were they the same at the receivers?

A. At the receivers, no, they were different. The windings had a different inductance in Tune A than in Tune B.

Q. What was the purpose of providing Tune B apparatus instead of Tune A apparatus, at Sagaponack?

A. Tune B apparatus was provided for the purpose of enabling the station to work to two or more ships when the adjacent station at Babylon was working probably to another ship within the range of that station.

Q. Did you have both Tune A and Tune B apparatus at Sagaponack?

A. Not when I originally went there.

Q. At any time did you have Tune A and Tune B apparatus at Sagaponack while you were there?

A. In my second visit, Tune A and Tune B were there, and we carried out experiments, as I said before, between Babylon and Sagaponack, with Tune B apparatus.

Q. How did the wave-length of Tune B apparatus compare with the Tune A apparatus?

A. Tune B was much longer than Tune A.

Q. Have you stated, Mr. Taylor, whether the receiving oscillation transformer of Tune B was the same or different from that of Tune A?

A. The oscillation transformer for Tune B was different from that of Tune A.

Q. How did it differ?

A. It differed in the amount of inductance in the secondary circuit.

Q. What values of condenser were used in the receiving detector circuits of Tune B?

A. The value was fixed at the Marconi works and was not changed at the station, and I could not tell you what the exact value was.

Q. And how about the value of the capacity in the detector circuit of Tune A apparatus?

A. That also was fixed in the oscillation transformer, and I have no knowledge of the exact value of it.

Q. Can you state whether or not the values were the same in the Tune A and the Tune B, from your experience?

A. No, I could not.

Q. After you had been at Sagaponack for the length of time that you have mentioned, what next did you do?

A. I returned to New York and was sent to Chicago.

Q. For what purpose?

A. For the purpose of erecting a station at Chicago, and one at Milwaukee.

Q. Do you remember when this was that you went to Chicago?

A. It was in the spring of 1903.

Q. State whether or not you erected the two stations you have mentioned?

A. Yes, I erected the two stations, one at Chicago and one at Milwaukee.

Q. What apparatus did you put into those stations?

A. We put in Tune B apparatus.

Q. How did Tune B apparatus, which you put into the Chicago and Milwaukee stations, compare with that which you have described as being present at Sagaponack?

A. It was identical, except that the condenser, instead of being built up of Leyden jars, was made up of glass plate condensers in oil.

Q. What was the idea of using oil condensers, rather than Leyden jar condensers?

A. We were supplying a greater power at the Chicago station than at the Sagaponack station.

Q. What was the source of power at the Milwaukee and Chicago stations?

A. Motor generator set.

Q. Will you produce and identify a drawing showing this motor generator set?

A. (Witness produces drawing; reproduced opposite.)

Q. Give it to the court?

A. (After handing drawing to the court.) Figure 3 shows the motor generator set.

Mr. Hughes: It will be shown in the record, by the reporters, that what the witness has referred to as Figure 3 is a designation appearing upon the blue print, the print itself being marked plaintiff's exhibit "27, T-5". (Claimant's Exhibit #161.)

[fol. 1040] Mr. Betts:

Q. Go ahead, Mr. Taylor.

A. What is the question?

Q. Will you please describe the motor generator transmitting apparatus illustrated in this diagram?

A. The motor generator set is illustrated by the portion marked a. The operating key is shown marked b, the transformer is shown marked c, the spark-gap marked g, the condenser the portion marked e, the primary of the oscillation transformer marked d, the secondary of this oscillation transformer is marked d', the loading coil is marked g, and the antenna marked A.

Q. What is the antenna circuit shown in this figure?

A. The antenna circuit is the portion marked f a g d' e.

Mr. Betts:

Q. What do the arrows on various part of that circuit indicate?

A. Indicate variability in the connections.

Q. And what is the spark-gap circuit?

A. The spark-gap circuit is the circuit marked g, e, d.

Q. Was e a fixed condenser or a variable condenser?

A. e was a fixed condenser.

Q. What does the arrow at d indicate?

A. d indicates that the inductance of that coil could be varied.

Q. What kind of a spark-gap was used at Chicago and Milwaukee stations?

A. Plain spark-gap between two brass spheres.

Q. How long were you in Chicago and Milwaukee installing these two stations?

A. I was there installing and operating them until October of that year.

Q. What year was that?

A. October of 1903.

Q. And what did you next do?

Mr. Hughes: Well, one moment. The blue print just described by the witness is offered in evidence as plaintiff's exhibit "27, T-5".

Blue print referred to was marked plaintiff's exhibit "27, T-5". (Claimant's Ex. = 161.)

A. I returned to New York.

Q. And after returning to New York, what work did you next do?

A. I was sent to the Marconi station at South Wellfleet, Mass.

Q. Will you point out to the court where that station is, upon the map which has already been referred to?

A. The station is marked here on the map, South Wellfleet, in red.

Q. Is that South Wellfleet station known by any other name?

A. Yes, it is frequently referred to as the Cape Cod station.

Q. Was the Cape Cod station erected when you first went there?

A. Yes, sir.

[fol. 1041] Q. Radio apparatus there?

A. Radio apparatus was all installed.

Q. Had the station been operating?

A. Yes, the station had been operating.

Q. In what way was the Cape Cod station used, for what purpose?

A. The station was then being used to test with the station erected by the Marconi Company in Nova Scotia, at Glace Bay.

Q. What kind of wireless apparatus was at the Cape Cod station in 1903?

A. The apparatus was of the tuned type.

Q. Can you refer to any of the drawings which you have produced as illustrating the Cape Cod station?

A. The drawings showing the Tune B apparatus would be diagrammatically correct for the Cape Cod station.

Mr. Hughes:

Q. You refer to the drawing shown in exhibits "T-3" and "T-4" (Showing).

A. Yes.

Mr. Betts:

Q. Now, Mr. Taylor, referring to the transmitter at Cape Cod station in 1903 while you were there, how many turns were there in the spark-gap circuit oscillation transformer?

A. There was less than one turn. The primary was usually built up on a separate former and wound around the three sides of a square former or if circled around almost to a complete turn and then the ends brought out for connections.

Q. And what can you say as to the condensers in the spark-gap circuit at Cape Cod, in 1903, while you were there?

A. They were of the glass plate in oil type, and their connections could be made, or broken, if necessary; but there was no provision made for altering these.

Q. Did they have at Cape Cod an induction ten-inch coil?

A. No, sir.

Q. What did they have?

A. They had two transformers.

Q. A motor generator circuit?

A. No, it was an alternator driven by an oil engine.

Q. How long did you remain at Cape Cod station this time?

A. Until March of 1904.

Q. What was the height of the antenna at Cape Cod station at that time?

A. The antenna was supported by four wooden towers, each of which was 210 feet high, and by two wooden masts, each of which was approximately 105 feet.

Q. How did the number of turns in the transmitting oscillation transformer at the Cape Cod station at this time compare with the Tune B oscillation transformer at Sagaponack?

A. We varied the number of turns in the oscillation transformer secondary, and each turn would be wound on a larger former than on the Tune B apparatus previously described.

Q. What kind of a spark-gap was used at Cape Cod in the fall of 1903 until March, 1904, when you left?

A. The spark-gap was what is usually known as the stationary type. It comprised two discs of iron, the face of each of which was approximately two inches wide, and the diameter was about eight inches, and each of these was kept revolving at a very slow speed. I should say from memory that they revolved once every two minutes.

[fol. 1042] Mr. Hughes:

Q. Every two what?

A. Every two minutes, so that, for all practical purposes, they were stationary gaps.

Mr. Betts:

Q. Now, referring to the receiving apparatus at Cape Cod, how did that differ, as to value, with the Tune B receiving apparatus at Sagaponack?

A. The oscillation transformer secondary was wound to be used for longer waves than for the Tune B, but, otherwise, it was the same.

Q. And the condensers in the receiver at Cape Cod and Sagaponack, were they of the same value?

A. The fixed condenser in the oscillation transformer was boxed and I could not tell you what its value was relative to the Tune A or Tune B condenser.

Q. What elements were in the transmitting antenna at Cape Cod station, which the operator could use to vary or adjust, in operation?

A. He could vary the inductance of the antenna circuit.

Q. And what elements were in the other transmitting circuit which the operator could vary?

A. Well, nothing was provided in the other circuit, but we always varied the condenser.

Q. How?

A. By breaking connection or making connection with

more or less rows of these tanks containing the condenser in oil.

Q. Did you finish your testing with the Glace Bay station before you left Cape Cod?

A. Yes, sir.

Q. And what was done, if anything, with the Cape Cod station then?

A. We started testing with the mercantile marine, ships that were leaving New York and sailing towards England.

Q. For what purpose?

A. For the purpose of establishing a news service to ships at a longer range than could be obtained at the stations at Sagaponack and Babylon.

Q. You say a longer range than Sagaponack and Babylon. What range?

A. About a thousand to thirteen hundred miles.

Q. Now, when you left Cape Cod in the spring of 1904, what next did you do?

A. I returned to New York and was sent to Alaska.

Q. For what purpose?

A. For the purpose of taking over some stations that had been erected for the company by Mr. Pfund.

Q. What kind of apparatus was at the Alaska stations?

A. It was the tuned apparatus of the Tune B type.

Q. Such as you have already described and illustrated in the drawings?

A. Yes, sir.

Q. Can you mention what those Alaska stations were?

A. The names or places at which these stations were erected were Fort Gibbon, Tolvana and Chenoa.

Q. How long were you up in Alaska on this job?

A. I came out of Alaska during February and March.

Q. Of what year?

A. 1905.

Q. And what did you do then?

A. On returning to New York, I was sent to Siasconset station and Babylon, and then went on a holiday.

Q. Now, will you point out to the court, on the map which you have already used, where the Siasconset station and where the Babylon station is?

A. The Siasconset station is on Nantucket Island off the [fol. 1043] coast of Massachusetts, and Babylon is at the New York end of Long Island. (Indicating on map to the court.)

Q. What kind of apparatus did you observe was at the Babylon and Siasconset stations when you were there in the spring of 1905?

A. Babylon had the Tune A and Tune B apparatus set up, and Siasconset had the Tune B apparatus.

Mr. Hughes:

Q. As you have described it in this diagram?

A. As I have described.

Mr. Betts:

Q. Now, after you had been to these two stations, what did you do?

A. I went to England on a vacation.

Q. On what ship?

A. On the "S.S. St. Paul".

Q. What kind of apparatus did the "St. Paul" have?

A. The "St. Paul" had Tune A apparatus set up.

Q. When, if ever, did you return to the United States?

A. I returned the same year. I believe it was the end of July or beginning of August that same year.

Q. And when you returned to the United States in August of 1905, what did you do?

A. I was sent down to the Sagaponack station.

Q. How long were you there at Sagaponack?

A. Approximately a month.

Q. What kind of apparatus did you see in use at Sagaponack in 1905?

A. Sagaponack was then using Tune A apparatus.

Q. After you had been at Sagaponack for a month, what did you next do?

A. I returned to New York and was sent to the South Wellfleet station again.

Q. That is the Cape Cod station?

A. The Cape Cod station.

Q. What apparatus was in use at Cape Cod station when you arrived there?

A. The same as that which I have previously described in my first visit there.

Q. How long were you at Cape Cod station?

A. I was there until 1909.

Q. In charge there?

A. In charge of that station.

Q. And during this period from 1905 to 1909, what kind of apparatus was used at the Cape Cod station?

A. The tuned apparatus such as I have already described.

Q. Tunes A and B or Tune B?

A. No, a larger tune,—it was a longer wave-length than Tune B, but the apparatus was substantially as shown for Tune B on the diagrams.

Mr. Hughes:

Q. You say the larger tune?

A. It was a longer wave-length.

Mr. Hughes:

Q. A long tune, not a large tune. I didn't understand what you said. I wanted the reporter to get it correctly.

Mr. Betts:

Q. And after you left Cape Cod station in 1909, what next did you do?

A. I was employed by the English Company to erect stations in the Amazon Valley in Brazil.

Q. And you were in their employ for that purpose for how long?

A. I was in their employ until 1912.

Q. When you came to the United States?

A. When I came to the United States, yes.

Q. Now, Mr. Taylor, during the period when you were [fol. 1044] in the employ of the American Marconi Company, from 1902 to 1909, did the American Marconi Company use any other kind of detector than the coherer which you have described?

A. Yes, we used the magnetic detector.

Q. Well, now, can you produce a diagram showing how the magnetic detector was used instead of the coherer? Go ahead, if you can.

A. A magnetic detector was used in a tuned circuit connected with the antenna circuit, such as I have shown in the tracing that I have here.

Q. Show that to the court, please.

A. (Witness shows tracing to the court.)

Mr. Betts: I offer a blue print of the tracing in evidence and ask that it be marked plaintiff's exhibit "27, T-6" (claimant's exhibit No. 162).

Blue print referred to was received in evidence and marked plaintiff's exhibit "27, T-6".

Mr. Betts:

Q. Did the Marconi Company use a magnetic detector in any other circuit than that which you have just illustrated or identified by the diagram?

A. Yes, they have used it in a third circuit with an intermediate circuit between the antenna and the detector circuit.

Q. Can you produce a diagram of that circuit arrangement?

A. Yes, that is shown in diagram marked 7.

Q. Show it to the court.

Witness hands diagram to the court.

Q. Now, referring to this diagram having the words "Marconi multiple tuner with magnetic detector", please describe the apparatus, beginning with f.

A. f is the antenna, g¹ is the variable inductance used in series with that antenna, h is a variable condenser also used in series with that antenna, j¹ is the primary of the oscillation transformer, and E is the earth connection.

Q. Was h a variable or a fixed condenser?

A. h is a variable condenser.

Q. Now, describe the next circuit, please.

A. The next circuit comprises the secondary of the oscillation transformer marked j², a variable capacity marked r¹, and an inductance marked t¹.

Q. Now, describe the next circuit?

A. The next circuit comprises an inductance marked t², a variable condenser marked h², and a magnetic detector marked m.

Mr. Betts: I offer this drawing in evidence and ask that it be marked plaintiff's exhibit "27, T-7".

Drawing referred to was received in evidence and marked plaintiff's exhibit "27, T-7" (claimant's exhibit #163).

Q. At what stations, Mr. Taylor, was the magnetic detector used and connected in diagram such as you have illustrated in exhibits "27, T-6" and "7"?

A. In "T-6" and "7"? At Sagaponack, at Milwaukee and at Cape Cod.

Q. Mr. Taylor, I show you four sheets of paper and ask [fol. 1045] you if you can identify them and state what they are? (Handing papers to witness.)

A. These are duplicates of shipping orders of material sent to Sagaponack station in the fall of 1902. One marked number "1" refers to transmitting jigger sent to me while I was at that station. One marked "13" refers to a Tune B transmitting figure sent to me. One marked "17" refers to a receiving jigger of Tune B type, and one marked "39" contains, among other things sent to that station, two magnetic detectors. That is in 1902 and 3.

Mr. Hughes:

Q. When you say marked you mean having at the top the numbers?

A. The reference number.

Mr. Hughes:

Q. The reference number.

A. Having reference numbers 1, 13, 17, 39.

Mr. Betts:

Q. In whose handwriting, if you know, are any of these papers?

A. Every one of them is in the handwriting of Mr. F. M. Sammis.

Mr. Betts: I offer these four sheets of paper in evidence and ask that they be marked plaintiff's exhibit "28".

Papers referred to were received in evidence and marked plaintiff's exhibit "28". (Claimant's Exhibit #167.)

Q. I show you another paper and ask you if you can state what that is? (Handing paper to witness.)

A. This is a copy of instructions issued by the Marconi's Wireless Telegraph Company, Limited, for the use of Marconi tuned apparatus for wireless telegraphy. This is dated the first of January, 1904.

Mr. Betts: I offer in evidence this paper and ask that it be marked plaintiff's exhibit "29".

Paper referred to was marked plaintiff's exhibit "29". (Claimant's Exhibit = 168.)

Q. Now, Mr. Taylor, while you were employed by the American Marconi Company from 1902 to 1909, what instrumentalities did you use in endeavoring to ascertain whether the transmitting circuits of the Tune A or Tune B apparatus which you have described were or were not in tune or in resonance?

A. We used to use a straight filament lamp placed in the antenna circuit, or else a hot wire volt-meter shunted across a small portion or small part of the antenna circuit.

Q. Explain a little more fully how, when you used the lamp, it showed whether the circuits were in resonance, or not?

A. The antenna circuit inductance would be varied until the lamp glowed at its maximum, and that point would be taken as the point of resonance.

Q. And what instrumentalities were used to determine whether the spark circuit of the transmitter was in tune or resonance?

A. In tune, what with?

[fol. 1046] Q. With the antenna.

A. Well, the variation was all done in the antenna, there was no variation made in the primary circuit or spark circuit of the transmitter.

Q. Now, referring to the receiving apparatus of tunes A and B, what instrumentalities were used to determine whether the aerial or antenna circuit was in tune or resonance with the detector circuit?

A. A small buzzer was used in the antenna circuit.

Q. Any instrumentalities used in the detector circuit?

A. None whatever.

Q. That was all done by the manufacturer?

A. Yes, that was fixed.

Q. When did wave-meters come into use, Mr. Taylor. I mean portable wave meters, so that you could measure wave lengths of radio circuit?

A. As far as I can recollect, they did not come into general use until 1908.

Q. Did you use wave meters while you were in the employ of the American Marconi Company?

A. No, we never used any portable wave meters in the tuning up of the various stations with which I was connected

in the employ of the American Marconi Company at that time.

Q. Are you familiar with the employment of wave meters at the present time to determine the wave-length of radio circuits?

A. Yes.

Q. What is the advantage of using wave meters over the use of your incandescent lamp that you have described?

A. The advantage is that with the wave meter you can tune your primary circuit independently of the secondary; you can tune your secondary independently or to the primary circuit, and it is possible to get a much closer adjustment of the tuning than you can get with the single tuning obtained by the lamp or voltmeter.

Q. Do you recall whether or not at any time, while you were in the employ of the American Marconi Company, any means was provided for getting sharp tuning in the detector circuit of the receiver?

A. Towards the end of the use of the coherer detector for commercial purposes, we used to put a variable condenser across the coherer itself, but that was only done occasionally, it was not general practice.

Q. Could you make a drawing showing this occasional practice?

A. Yes (reproduced opposite).

Mr. Betts:

Q. Mr. Taylor, can you now produce the drawing which I asked you to make before the recess?

A. This is the drawing referred to.

Q. Give the original to the court.

A. (The original drawing was handed to the court by the witness.)

Mr. Betts: I ask that this be marked plaintiff's exhibit "27, T-8".

Drawing referred to was received in evidence and marked plaintiff's exhibit "27, T-8". (Claimant's Exhibit \pm 164.)

[fol. 1047] Q. Mr. Taylor, will you now explain the drawing "T-8"?

A. The drawing "T-8" shows the tuned receiving apparatus used by the Marconi Company. The antenna circuit

is shown, marked f and d¹, and the secondary circuit is shown marked S J S¹ T, T being the coherer, and the variable condenser J¹, dotted, connected across that coherer.

Q. Where was such a receiving circuit used by the American Marconi Company while you were connected with it from 1902 to 1909?

A. We used such a circuit at Cape Cod or Sagaponack.

Q. Why did you use it at all?

A. It was used if the transmitting circuit was not directly in tune with the coherer circuit on the receiving apparatus, and this variable condenser J¹ enabled us to put the receiving circuit containing the coherer in better tune with the transmitting circuit.

Q. While you were with the Marconi Company from 1902 to 1909, were any other forms of transmitters used than that which you have called Tune A and Tune B?

A. Yes, we used plain aerial.

Q. Can you produce a drawing illustrating that?

A. Yes. (Producing.)

Q. Give it to the court.

A. (Witness handed drawing to the court.)

Mr. Betts: Mark it "T-9", please.

Drawing referred to was received in evidence and marked plaintiff's exhibit "27, T-9". (Claimant's Exhibit #165.)

Q. Will you now explain to the court your sketch "T-9"?

A. The exhibit "T-9" shows the early type of Marconi transmitter, in which the antenna circuit is marked f to E, and the spark-gap S.G. directly on it. This spark-gap is connected across the secondary of a ten-inch induction coil marked "induction coil" and the primary circuit is shown energized by a battery marked b, and the manipulating key is shown, marked k.

Q. What was the transmitter shown in your exhibit "T-9" used for?

A. It was used for emergency purposes.

Q. What do you mean by emergency purposes?

A. When the ship that we were working with could not receive on Tune A or Tune B apparatus.

Q. Now, Mr. Taylor, I call your attention to your drawing "T-5", entitled "Tuned transmitter using motor generator" set. This drawing shows some clips on the coils of the transmitters. Will you state whether or not such sets were used or worked?

A. This drawing has reference to the set that was used at the Milwaukee and Chicago stations. That was not a commercial set, and was installed with clips for the purpose of carrying out experimental work.

Q. Now, in the Cape Cod, Babylon and Sagaponack stations that you have referred to, how many turns were in the primary of the transmitting oscillation transformer?

A. There was just less than one turn in each of the oscillation transformer primaries on each of those stations whilst I was there.

[fol. 1048] Q. That was the universal practice?

A. That was the universal practice of the Marconi Company.

Q. Now, when you were at Cape Cod from 1905 until 1909, what was that station doing, if anything, in a commercial way?

A. It was transmitting news from the shore to the commercial ships that were fitted with Marconi apparatus.

Q. To what distance was this communication?

A. The communication was to the limit of thirteen hundred miles.

Mr. Farnsworth:

Q. You know that of your own knowledge?

A. Yes.

Mr. Betts:

Q. I now show you an exhibit marked plaintiff's exhibit "K" (Claimant's Ex. 153) and ask you if you can identify that exhibit and state to the court what it is? (Handing paper to witness.)

A. This shows the interior of a Marconi wireless station, showing ten-inch induction coil, with two trays of Leyden jars, one of which is the six used for the Tune A apparatus, and the other the fifteen used for the Tune B, and besides them is the coherer type of receiving apparatus.

Q. Just point that out to the court on the photograph, please.

A. This is the ten-inch induction coil, and here is the battery of six Leyden jars for the Tune A apparatus, and here is the battery of fifteen for the Tune B, and these are the coherer receivers.

Q. Whose photographs or pictures appear in that exhibit, if you know?

A. In the foreground here is Mr. Chavlier, who was at Sagaponack with me, and this man is Mr. Brennan, who was in the Marconi Company's stores or workshop in New York, and the third man I do not know, or I do not recognize him.

• • • • •
Mr. Betts:

Q. I now show you another exhibit, marked plaintiff's exhibit "J" (Claimant's Exhibit No. 152), and ask if you recognize that, and, if so, state what it is, exhibiting the same to the court.

A. This is a print of the Franklin multiple tuner such as was used at the Marconi shore stations at Sagaponack, Babylon, Siasconset and Cape Cod, at which I was employed.

• • • • •
Q. Referring to plaintiff's exhibit "29" (Claimant's Ex. 158), Mr. Taylor, which you have already identified, what can you say further as to that?

A. These are the instructions issued by the English Marconi Company for use with Tune A and Tune B apparatus, and were copied by the American Company and issued to their stations, and a copy of which was sent me while I was on one of their stations in 1904.

Q. From your practical experience, Mr. Taylor, what are the advantages of using coupled tuned circuits at the transmitter and coupled tuned circuits at the receiver?

A. For the same initial energy we get a louder signal at the distant receiving station, and the reception is easier because the circuits are more selective.

[fol. 1049] Q. In your experience as a radio engineer, particularly in long distance wireless work, what can you say as to whether or not continuous communication could be maintained between San Francisco and Honolulu without the use of tuned circuits of the transmitter and tuned circuits of the receiver?

A. In my experience, I would say that if the circuits of the transmitting station were not tuned and the circuits of the receiving station were not tuned and had no harmonious relation with one another, the amount of energy required at the transmitting station would make such a combination commercially impossible.

Q. Is there any other advantage than that of long distance communication with a small amount of power in the

use of coupled tuned circuits of the transmitting and receiving stations, from your practical experience?

A. Well, we are able to work duplex at our transmitting stations, for instance, the station at Honolulu can work to Japan or to San Francisco at the same time as San Francisco and Japan stations are working to it, and the station at San Francisco can work to Honolulu at the same time as the Honolulu station is working to San Francisco.

Q. From your own practical experience, can you state as to whether or not messages have been actually received and sent from San Francisco to Honolulu with the use of coupled tuned circuits at both stations?

A. The Marshall station of the Marconi Company has received messages from the Funabashi station in Japan by the use of coupled tuned circuits, but the Marshall station has not engaged in any test for transmitting to Funabashi.

Q. The Marshall—

A. The Marshall station has not engaged in any transmitting test to the Funabashi station of the Japan government.

Q. Well, now, as between Honolulu and San Francisco, what can you say as to the use of coupled tuned circuits between those two stations?

A. The coupled tuned circuits are always used between the Marconi stations at Honolulu and San Francisco.

Q. What is the distance between the Japanese government station and the Marshall station you have referred to?

A. I have never measured it out or calculated it, but I should imagine it was about five thousand miles; probably slightly under.

Q. From your experience with radio telegraphy, what is the minimum and maximum wave-length used commercially?

A. The maximum wave-length that we have employed in the Marconi long distance stations is approximately 16,000 meters, and the smallest wave-length that I am aware of that has been used is 100 meters.

Q. Mr. Sammis has testified for the defendant that "Practically the only time that the coupled sets were used was when from storm or damage the antenna installation became so low as to prohibit the spark. * * * The station at Sagaponack, New York, is a particular example. This station operated with an inductance coil sparking directly into the antenna and right up to the time the plain

aerial was prohibited by law." What can you say, Mr. Taylor, from your own personal knowledge, as to the truth of Mr. Sammis' statement?

A. From my own personal knowledge, I know that the Sagaponack station used Tune A all the while I was there, [fol. 1050] The only time that the spark-gap was put in the antenna was, as I said before, in case of emergency.

Mr. Betts: I want to introduce in evidence the map referred to by the witness during the direct examination as plaintiff's exhibit "30".

* * * * *

Map referred to was marked plaintiff's exhibit "30".
(Not offered in present case.)

Cross-examination.

By Mr. Farnsworth:

Q. Mr. Taylor, what is the power of the transmitters of the Marconi Company at Hawaii and San Francisco?

A. The alternator used for energizing the condenser bank has a rated capacity of 300 kilowatts.

Q. At each transmitter?

A. Yes, at each transmitter.

Q. The Federal Company, with the Poulsen system, also operates between Hawaii and San Francisco, does it not, or between Honolulu and the Pacific Coast?

A. So I understand.

Q. A regular commercial communication?

A. So I believe.

Q. What power have their transmitters in that communication?

A. I do not know. I never have been in their station.

Q. You don't know whether or not it is as large as the Marconi power?

A. No, I have no knowledge of it.

Q. You know, do you not, that the system of the Poulsen type, applied by the Federal Company, is that employing a single oscillating circuit at each station and not coupled tuned circuits, don't you?

A. No, I do not.

Q. What is the shortest wave which the regular receivers at Marshall's, in Honolulu, Marconi High-power station, can receive?

A. Those receivers are adjustable in every particular and we can arrange to make them tune to almost any wave.

Q. What is the shortest?

A. The shortest wave that we have actually tuned to is about 2,000 meters.

Q. In your experience in radio telegraphy, which type of transmitter will transmit the longest distance, the old plain aerial type or the coupled tuned circuit type, other conditions being the same as to power and so forth at the transmitter?

A. That will depend on the type of receiver that was used.

Mr. Farnsworth:

Q. What form of Marconi apparatus was used on the steamship on which you returned from England to the United States, in 1905?

A. I returned in the Steamship "St. Paul", and that station was equipped with Tune A and Tune B apparatus.

Q. In your experience in this country with the American Marconi Company you didn't have much opportunity to become acquainted with the plain aerial or single oscillating circuit transmitters used by the American Marconi Company, did you?

A. Not while I was in their employ.

Q. Those were mostly used on the ships, rather than on the land stations?

A. That I could not say.

Q. Referring to plaintiff's exhibit "27, T-7" (Claimant's [fol. 1051] Ex. 163), will you please step to easel and make a drawing of the circuits of that receiver employing a magnetic detector, in which you will show the circuits of the magnetic detector in full, as indicated only diagrammatically at M in said exhibit?

A. The whole?

Q. The whole receiver?

A. (After drawing.) There is the drawing, Mr. Farnsworth.

Q. Mark it, Mr. Taylor, with your initials.

(Drawing referred to was marked "T-10".)

Mr. Farnsworth: "T-10". That is offered as defendant's exhibit.

(Received in evidence and marked plaintiff's exhibit "27, T-10".) (Claimant's Ex. \pm 166.)

Q. Explain, please, with the letters of reference on the chart "T-10", just where the magnetic detector is and what its parts of the circuit are.

A. This is the magnetic detector. This part is—

Q. Mark it, please, and specify it.

A. M-1 shows the primary coil of the magnetic detector, and M-2 shows the secondary coil of that detector, and T shows the telephones.

Mr. Hughes:

Q. The letter "T"?

A. The letter "T".

Mr. Farnsworth:

Q. Mr. Taylor, referring to your drawing at "T-9", you have marked that "Early Marconi transmitter untuned plain aerial." State, please, what you mean by untuned.

A. I mean that there were no coupled circuits, there is only one circuit in which the frequency is a radio frequency.

Q. When you show two coupled circuits in your other diagrams, that is why you call them tuned?

A. The two coupled circuits. The transmitter shows that the two coupled circuits are those in which we have tuned relation between the two circuits.

Q. Yes, and when there is only one circuit at transmitter or receiver, you call that an untuned receiver?

A. There is only the single circuit there, and there are not two circuits, no, untuned in the radio frequency.

Q. You never in your experience knew of the plaintiff's aerial, such as in your T-9, being tuned to the aerial of the other station.

A. I am referring to the tuning of the transmitting apparatus in itself.

Q. Yes, and two circuits together.

A. The two circuits—

Q. I will ask you if you ever have known in your experience whether or not, with a plain aerial transmitter and receiver, where there was a single oscillatory circuit—whether you have ever known of one aerial of one station being tuned to the aerial of another station, as in your T-9?

A. No, I don't think so, as far as I can recollect.

Q. You don't know of any cases where two stations were tuned to each other, where at each station there was only one radio circuit, such as the antenna?

A. A single radio station in each circuit?

Q. In each station.

A. Not as far as I am aware of, no.

Q. Before wave-meters came into use, which I think you said was about 1908, how did you practitioners in the art manage to get, in each of the two circuits at each station, [fol. 1052] that is, four circuits at the Marconi system, the product of the inductance and capacity in each circuit exactly the same as the product of inductance and capacity in the other circuits?

A. In my experience, I could not say that we did get the product of those two quantities identical in both stations but we got it as near as we possibly could.

Q. You constructed or adjusted until you got the best results in practice?

A. Yes. We altered the antenna circuit until we got the maximum relation between the two, as far as we could.

Q. Yes, the adjustment or construction being *empirical* until you got the best results?

A. To a large extent, yes.

Q. Well, just what was shown to your satisfaction by the instruments you did use prior to the time you began to use the wavemeter? That is, I think you said they were a lamp and a hot wire—

A. A hot wire volt-meter or a lamp.

Q. Describe fully the use of those for that purpose in aiding you in making those *empirical* adjustments to get the best results?

A. We put the indicating instrument, whether it was a hot wire voltmeter or lamp, in the lower part of the antenna circuit, varying the inductance of the antenna circuit until this lamp or voltmeter gave us maximum indication showing that the indication was a maximum on the instrument, where the lamp glow was brightest. The final tuning was done by having the receiving station correct that adjustment, if necessary.

Q. So that if you did not get the two circuits of the transmitter into tune with each other, you could remedy that defect by adjusting the distant receiver?

A. We could get the best effect out of that circuit.

Q. And the adjustment you made, or construction, at the receiver, were empirical, as indicated by the best results you got at that receiver?

A. By the best results, yes, sir.

Q. Now, when the maximum indication was shown by the lamp or instrument, hot wire instrument, that indicated, did it not, as you understand it that the maximum current was flowing in that circuit?

A. Yes, it——

Q. Or energy?

A. It gave the indication of maximum flow of energy.

Q. It was due to that flow in the circuit of the maximum energy or current that you got the best results in transmission of radio communications?

A. No. The instructions showed that the best point very [fol. 1053] often was the slightest bit off to one side of that maximum.

Q. It was very near that maximum?

A. It was near that maximum, yes.

Q. As to any of your drawings that you have submitted today, in addition to giving the operation of some of the parts in those cases, can you state the wave-length or frequency of those circuits?

A. I have never measured them for wave-length or frequency of those circuits. I have never measured them for wave-length or frequency when we had a wave meter.

Q. Can you state whether any of those circuits of your sketches today, as specified to exemplify the ancient practice of the Marconi Company—can you state whether or not, as a matter of fact, in practice, the circuits in two or more of them ever did have substantially the same wave-length or frequency as the others?

A. Yes. The majority of those for Tune A had the same frequency, or very approximately the same frequency; and the same with Tune B.

Q. How do you know that?

A. Because the secondary circuit in the coherer circuit was fixed and had a definite period of its own.

Q. How do you know that, were you constructor?

A. Yes, I was constructor for part of the time.

Q. That is the fact, is it, that as on your drawing T-2 and T-4, namely that the secondary or coherer circuit of those receivers had substantially the same frequency or period as the antenna or aerials?

.

A. T-2 and T-4, or T-2 and T-5?

Q. Mine is marked 4.

(Question read.)

Q. The antenna circuit in both instances was tuned to the fixed circuit at the receiver containing the coherer.

Q. The coherer in the coils s¹ s¹ and the condenser j?

A. Yes, and condenser j.

Q. What is it, j s?

A. j¹ and j s. J¹ in exhibit "4" and j s in exhibit "2".

Q. Yes, that is, you state that as a fact, do you, both as [fol. 1054] being a constructor of that apparatus and as a practitioner with it?

A. Yes, we constructed the antenna to correspond to the secondary circuit of the coherer.

Q. Yes. You are absolutely certain of that, namely, that in T-2 and T-4 the two receiving circuits, namely, the aerial and the secondary circuit, including the coherer, did have substantially the same wave frequency or tune or period?

A. So far as our apparatus would inform us.

Q. So far as what?

A. So far as our apparatus would let us know.

Q. So far as your apparatus would let you know?

A. Yes.

Q. Just explain what you mean by that. I don't quite get that.

A. Well, we had no means of finding out the definite periodicity of the circuit like we have nowadays with the wave meter, and, so far as the indications would go, the two circuits were in resonance.

Q. Namely, the indications being what?

A. The indications, in case of the transmitter, would be the hot wire voltmeter or the lamp, and in case of the receiver, it was the maximum signals in response to the buzzer on the antenna circuit.

Q. Yes. Then, as I understand you, as to the transmitter, you used the instruments you have mentioned, the lamp and the hot wire instrument, to obtain substantially the greatest current in the transmitter, and then, to get the best conditions at the receiver, you adjusted or constructed the receiver so that you got the best results at the receiver from such a transmitter?

A. Yes.

Q. And you never knew, otherwise, whether or not the product of the inductances and capacities of those circuits, or any of them, were substantially the same in each and all of the circuits?

A. So far as I am aware, I had no knowledge of the product of the capacity and inductance in each of these stations.

Q. Now, Mr. Taylor, you said, I think, that the wave meter used nowadays had an advantage over the use of the lamp instrument and hot wire instruments, in that you thereby get closer tuning of these four circuits. Can you now go further and state what advantage arises from obtaining closer tuning?

A. Well, closer tuning would cause a greater amount of energy in the antenna circuit.

Q. At the transmitter?

A. At the transmitter, and that would cause a better signal on the receiving instruments.

Q. Yes. That is, when you were able to get a condition of closer and closer approximation to the same periods in the primary of the closed circuit of the transmitter and the antenna, then you got better conditions of the radiation from the transmitter?

A. Yes.

Q. And, similarly, at the receiver, when you can get the receiving antenna into closer and closer approximation to the exact tuning between the antenna and the closed secondary circuit, then you get the best results at the receiver?

A. Yes.

Q. The wave meter is, you think, quite useful for the purpose of getting such closer tuning of those two circuits in each station and the four circuits at both stations?

A. Yes, I believe that we can get nowadays, with the wave meter, a much better tuning relationship than we could get in the old days without it.

[fol. 1055] Q. Well, now, as to the receiver, can you tell me, as between T-2 and T-4 on the one hand, compared with T-8 on the other, you can get closer tuning in the receiver secondary, that is, in T-2 and T-4 there is no condenser, variable or otherwise; around the detector; but in T-8 there is.

A. I would not say that the T-8 form gave us closer relationship, but at that time there were so many ships being

equipped and the transmitting apparatus was not as well tuned as it should be, and in some instances the additional condenser was used in order to make that circuit more responsive to the improperly tuned transmitting apparatus.

Q. Yes.

Mr. Betts:

Q. You are referring now to which sketch?

A. T-8.

Mr. Farnsworth:

Q. Then I take it that with T-2 and T-4 the tuning of that secondary circuit, including the coils, the condenser between them and the coherer detector, you could get in that secondary just substantially as close tuning as you could in a secondary like T-8 where the coils *s* and the condenser *J* have also a condenser *J*¹ included in that circuit.

A. The results obtained with the circuit as shown in Figure 2 were sufficient for the commercial work that we were doing at that time.

Q. Yes, but could you get just as close tuning with that secondary as you could with the one at T-8, where it was a variable condenser in shunt?

A. I have not made a comparative test of that.

Q. The matter of difference was not of sufficient importance to investigate it, so far as you know?

A. No.

Mr. Farnsworth:

Q. As to this variable condenser of T-8 in the secondary, I think you said that you found it was advisable to use that because by an adjustment of that variable condenser you could get better results at the receiving station from the transmitter when the tuned circuits of the transmitter were out of tune with each other; is that correct?

A. I said that was what was done; not that I could do it.

Q. Well, that was what was done, you have seen it done?

A. Oh, yes, I have seen it done.

Q. Now, do you know, have you any knowledge, as a matter of fact, of just what happens there in practice?

A. I don't quite understand your question.

Q. When the two circuits of the transmitter are out of tune, do you know, as a matter of fact or observation, what

happens in the radiation from that transmitter, whether one wave or more? What did you see, observe at the times you have testified you used this apparatus?

A. From personal observation, I never thought that that condenser was any use possibly, and very seldom used it in any station I was at.

[fol. 1056] Q. You are stating an answer I didn't ask for. I am asking for facts. What do you say you observed in those stations, at the stations where you worked?

A. There was nothing to take any measurement.

Q. Didn't you measure the waves emitted from a transmitter out of tune?

A. There was no wave meter in those days.

Q. You didn't have any wave meter?

A. No.

Q. Even in the experiments you could not tell the character of radiation from the transmitter, where the two circuits of the transmitter were out of tune with each other?

A. We had means of telling whether we got a received impulse or not.

Q. That is all?

A. That was all.

Q. When a transmitter had its two circuits out of tune, you could not tell, without any wave meter, what the character of the radiation was from that transmitter?

A. We could tell, from the hot wire meter. If we put that in and tested it over the whole range, we probably could have told the——

Q. I mean of course as to whether there were one or two waves?

A. Not in commercial stations, we could not in commercial operation.

Q. You had no means of telling whether, from such a transmitter having two circuits out of tune, there were more than one wave emitted?

A. No, we could not tell in the receiver in those days.

Q. Then I take it you do not know the fact, if it be a fact, that that variable condenser in the secondary of the receiver T-8 had any useful effect in adjusting that receiver so as to receive transmission from a transmitter where the two circuits were out of tune, you don't know the facts as to that?

A. No, I don't know.

Q. And you don't know because you had no means of giving the emitted waves?

A. We had no means of measuring the waves.

Q. In those circuits of those various sketches to which you have referred today, couldn't you calculate, from the dimensions of the reactances, namely, the condensers and inductance, what the periods of frequency of the various circuits were?

A. They got that clearly, yes.

Q. Did you ever do it?

A. No.

Q. Why not?

A. I was employed in construction work most of the time.

Q. You never did that even in your construction work?

A. No.

Q. You constructed these apparatuses containing these supposed tuned circuits without any calculating, or having calculated for you, the periods or frequency of those circuits?

A. We received instructions as to what to use for Tune A and Tune B and we carried those out.

Q. Yes, and if you varied them in constructing or use in operating them, you didn't know what the periods or frequencies were in those circuits?

A. No, we didn't know.

Q. Referring to your various drawings which you have offered today, could any one of those transmitters, that is, [fol. 1057] Tune A or Tune B, radiate at different times more than one wave-length?

A. Yes, they could both radiate more than one wave-length.

Q. How is that?

A. With two coupled circuits you can get two wave-lengths.

Q. At the same time you mean?

A. Yes.

.

A. At the same time, yes, with coupled circuits you can get two waves at the same time from a transmitter.

Q. Coupled tuned circuits?

A. Coupled tuned circuits.

Q. How is that an advantage as observed by you at the receiving stations at which you worked.

.

A. We had no knowledge that two waves were being emitted at those stations.

Q. Yes; I think you really misunderstood me, Mr. Taylor. I asked you, or tried to ask you, whether those old transmitters, Tune A or Tune B, either of them, could be or were changed for the purpose of changing the emitted wave-length to a different one?

A. Were changed?

Q. Yes.

A. I don't quite understand you.

Q. By the operator, say.

A. No, in the Tune A and Tune B apparatus nothing was provided for making any changes by the operator.

Q. Yes. Now, then, the operator of such a transmitter as either Tune A or Tune B was limited to one wave-length in the use of that transmitter?

A. Yes, he could only use the wave-length as set up by the engineer.

Q. Yes. And the same is true, as you have just stated, also in respect of the Marconi receivers Tune A or Tune B respectively?

A. He could make no alteration in the secondary circuit of that coherer receiver.

Q. Do you know as a matter of fact, from your experience as a practitioner at the various stations at which you have been employed, whether you could receive efficiently, at a receiver such as Tune A or Tune B, an emitted complex wave of two frequencies?

A. No.

Q. Why couldn't you?

A. Not knowing what the radiated wave was, I had no means of telling.

Q. Because you had no wave meter?

A. We had no means of telling what the radiated wave was, whether it was, whether it was simplex or complex.

Q. Well, in one of those Tune A or Tune B receivers, could you in either one of those at one time receive messages from two distant and different transmitters each having a different wave-length?

A. We could receive the radiation from the Tune A station, and if a station was using another wave within a [fol. 1058] very short range, it would probably impulse the aerial and cause a signal on the receiving current.

Q. Answer the question without referring to very short range.

A. At long range the Tune A receiving apparatus would receive only on the Tune A.

Q. Yes.

A. Using the same power for the two sets.

Q. Yes. Is that why, on occasions, at the place where one receiving operator was, he was provided with two complete receivers, that is, Tune A and the Tune B?

A. I could not say what the object of the Marconi Company was in providing more than one receiver.

Q. Well, the result, as you practically observed it, was that when he had both the Tune A and Tune B receiver he could then work, as I take it, with a distant Tune A and Tune B transmitter?

A. He could work with a distant Tune A, and Tune B transmitter, certainly.

Q. And not with any other transmitted waves of different length than those emitted from Tune A and Tune B transmitter?

A. Well, he would have no knowledge of waves other than those—

Q. Yes.

A. (Continuing)—emitted by Tunes A and B.

Q. He would have no means at the place where he was of knowing whether waves of any other frequency were being transmitted from anywhere?

A. No. In working on the coherer, he would have no knowledge of such things.

Mr. Betts:

Q. How?

A. Working on the coherer.

Mr. Farnsworth:

Q. His senses then would be closed to any third station or distant transmitter at any different wave-lengths from either Tune A or Tune B transmitters?

A. Yes.

(Witness excused.)

Mr. Cosgrove: Claimant's counsel offers in evidence the exhibits referred to in the stipulation and the testimony, and the same are marked as specified in the stipulation.

Mr. Cosgrove also reads in evidence the following stipulation entered into between counsel:

"It is Stipulated and Agreed that the annexed copy of the pleadings and evidence under the supplemental bill in the suit in Equity No. 12 31, in the United States District Court for the Southern District of New York, of Marconi Wireless Telegraph Company of America, the claimant herein, against DeForest Radio Telephone & Telegraph Company, on the Fleming patent No. 803,684, is a true copy of the original of such pleadings and evidence, and may be offered in evidence herein, subject to the objections of the defendant, with the same force and effect as the original of said pleadings and evidence, or a duly certified copy thereof.

It is further Stipulated that a copy of said pleadings and evidence was marked for identification herein by the claimant in the taking of the evidence of Frank N. Waterman, a witness called on behalf of the claimant (Vol. 1, Record p. 264) and that such evidence is referred to in the evidence of John M. Miller, a witness called on behalf of the defendant herein and quotations made therefrom.

[fol. 1059] Mr. Cosgrove: Claimant's counsel offers in evidence the last-mentioned stipulation as "Claimant's Exhibit No. 170 Stipulation in Record Suit of Marconi *vs.* De Forest".

Claimant's counsel also offers in evidence the Pleadings and Evidence annexed and referred to in the last-mentioned stipulation, and the same is marked "Claimant's Exhibit No. 171. Pleadings and Evidence in Case of Marconi Wireless Telegraph Company of America *vs.* De Forest Radio Telephone & Telegraph Company".

Deposition of JOHN J. BRENNAN, for claimant, taken at New York, N. Y., on the 8th day of October, A. D. 1925

First interrogatory by the Notary: State your name, your occupation, your age and your place of residence; whether you have any, and if any, what interest direct or indirect, in the claim which is the subject of inquiry; and whether, and in what degree, you are related to the claimant.

Answer: My name is John J. Brennan; age, 53 years; residence, 219 Harrison Avenue, Jersey City, N. J.; occupa-

tion, Foreman of the Maintenance and Repair Division of the Sales Service of the Radio Corporation of America; I have no interest direct, or indirect, in this claim and am not related in any way to the claimant.

Direct examination.

By Mr. Cosgrove:

Q. 1. Are you the same John J. Brennan who testified in this case in April 1917?

A. I am.

Q. 2. How long have you been in the employ of the Radio Corporation of America?

A. Since 1919, when the Radio Corporation of America took over the Marconi Wireless Telegraph Company of America.

Q. 3. What department of the Marconi Company referred to in your last answer did you work in from 1909 to 1916, inclusive?

A. The Maintenance and Repair Department.

Q. 4. What work did you do in or for that department during those years?

A. We manufactured transmitters and receivers and also the Marconi valve receivers, rotary gaps, oscillation transformers and parts necessary for the manufacture of complete wireless equipment.

Q. 5. What position did you hold in that department during the years 1909 to 1919, inclusive, and what work did you do in that position?

A. I was Foreman of that department; it was my duty to see that all orders were carried out.

Q. 6. What kind of orders?

A. Such as repairs to equipment on vessels when orders were issued that there was trouble on any vessel.

Q. 7. What work did you do in connection with manufacturing any of the wireless apparatus for the Marconi Company?

A. I looked after personally myself the manufacturing of the various parts of these apparatus.

Q. 8. Did you do any repair or maintenance work at the shore stations of the Marconi Company or on vessels equipped with its wireless apparatus, and if so, during what period was the work done?

[fol. 1060] A. Yes, between the period of 1909 and 1912 I visited the vessels as they came into port and tried out the apparatus, such as the Marconi valve receivers, and if possible, made the repairs while there; I also visited the John Wanamaker Station of New York City, at various times, upon complaint of trouble, and made the repairs.

Q. 9. Do you remember about what month and year you visited the John Wanamaker Station in New York City?

A. I visited that station from the early part of 1910 to about 1912, at various times.

Q. 10. What kind of a station was this John Wanamaker Station?

A. This was a Marconi wireless telegraph station of 5 KW output, conducting business between the Wanamaker stores in New York and Philadelphia.

Q. 11. Whose wireless apparatus was this Wanamaker station equipped with?

A. This was equipped with the Marconi Wireless Telegraph Company of America set.

Q. 12. During the period from 1909 to 1916, inclusive, did you visit any other shore station of the Marconi Wireless Telegraph Company of America?

A. Yes, I visited our station at Sea Gate, Coney Island, New York.

Q. 13. Do you recollect about when you visited the Sea Gate station?

A. Yes, it was around 1911; how many times I visited the station I cannot definitely state now, but it was at various times.

Q. 14. Where did the Marconi Company manufacture the wireless apparatus which you stated in your answer to Q. 4 was manufactured by that Company?

A. 37 Water Street, 125 Front Street, 29 Cliff Street, Edison Building, 27 Elm Street, New York City.

Q. 15. During the period between 1909 and 1916, inclusive, what, if any, stock of wireless apparatus did the Marconi Company keep on hand?

A. We kept a more or less complete line of parts for manufacturing purposes, such as valve tuners, rotary gaps, oscillation transformers and all parts pertaining to the complete manufacture of wireless equipment.

Q. 16. Did the Marconi Company keep on hand any types of detectors during this period, and if so, what types of detectors?

A. Yes, we kept large quantities of Fleming valves; also the magnetic detector parts and crystals.

Q. 17. When you speak of Fleming valves, what kind of a device have you in mind?

A. This is a lamp similar to the incandescent bulb, with a filament inside and a metal plate alongside of the filament, with leads coming through the glass to the outside of the bulb.

Q. 18. What disposition did the Marconi Company make of the wireless apparatus manufactured by it?

A. We equipped ship and shore stations with this apparatus manufactured by us.

Q. 19. Did you sell any of the apparatus?

A. Yes, we sold this to commercial companies and individuals as well; we also rented same to them.

Q. 20. What did you have to do, if anything, with receiving and shipping Marconi valve receivers and Fleming valves during the years from 1910 to 1915, inclusive?

A. This was a part of my work, and upon receipt of orders from the main office we would place orders through my assistants to ship these to the various Marconi shore stations and vessels.

Q. 21. Did the Marconi Company manufacture the Fleming [fol. 1061] ing valve referred to?

A. No, we had these manufactured for us by various companies; we also received a number from the English Marconi Wireless Telegraph Company.

Q. 22. State, if you know, by whom the Fleming valves were manufactured for the Marconi Company.

A. We had them manufactured for us by the General Electric Lamp Works, of Harrison, New Jersey, Tungsten Lamp Repair Company of New York City and the McCandless Lamp Works of New York City.

Q. 23. In your answer to Q. 21 you stated that you had received a number of Fleming valves from the English Marconi Company. Can, and will you produce a specimen of the Fleming valve received from that Company?

A. I can, and do.

Q. 24. Will you state, if you can, when this Fleming valve was received from the English Marconi Company?

A. I cannot state positively when this particular valve was received, but we received a number of the same kind between the early part of 1910 and up to 1911.

Q. 25. How long has this Fleming valve you have produced been in your possession?

A. This valve has been in my possession from about 1912 until two or three years ago, when I turned it over to Mr. George Clark, and obtained it from him a short while ago.

Q. 26. I notice an inscription on the bulb of the Fleming valve you have produced, and which appears to be etched into the bulb. Please read it.

A. "Fleming Oscillation Valve 12 Volts", and on the other side of the bulb it is marked "Royal Ediswan".

Q. 27. Do you know what the word "Ediswan" refers to?

A. To an English Company who manufactured the valve for the English Marconi Wireless Telegraph Company.

Mr. Cosgrove: Claimant's counsel offers in evidence the Fleming valve produced by the witness and the same is marked "Claimant's Exhibit No. 172, English Fleming Valve."

Q. 28. In your former deposition you referred to and produced a Fleming valve marked "Plaintiff's Exhibit 29, Fleming Valve". Will you please state for whom, and by whom, this valve was made, if you know?

A. This valve was manufactured for the Marconi Wireless Telegraph Company of America by the General Electric Lamp Works of Harrison, New Jersey.

Q. 29. Can you state about when that valve was received by the American Marconi Company from the General Electric Lamp Works?

A. No, not that particular valve; but I have seen numerous ones of the same type between 1910 and 1912.

Q. 30. I show you six articles. Will you state if you know, what they are?

A. These are Fleming valves.

Q. 31. For how long past have you known of the existence of these six Fleming valves?

A. These valves have been in my possession from 1910 up to the present time. Some of these valves are of the manufacture of a slightly later date than 1912 and 1913.

Q. 32. One of the six valves you have produced has a small tag attached to it, marked "O. K. 10 - 19 - 12. 10 V. Fair H. E. H.". Please state if you know what that inscription or marking means?

A. This refers to the date when this valve was tested by our inspector, Mr. Halberg and the marking "10-19-12"

means October 19th, 1912, and apparently worked best on 10 volts on test.

Q. 33. Do you know in whose handwriting the inscription [fol. 1062] on the tag is?

A. Only from seeing Mr. Halberg's signature at various times; I would say that this is his own handwriting.

Q. 34. Do you know where Mr. Halberg is at the present time?

A. Mr. Halberg is now connected with the engineering department of the Radio Corporation of America; I don't just know what branch.

Mr. Cosgrove: Claimant's counsel offers in evidence the Fleming valve last referred to by the witness and requests that the same be marked "Claimant's Exhibit No. 173, Fleming Valve".

(Said exhibit so marked by the Notary.)

Q. 35. Another one of the six valves you have produced has a tag attached to it, on which appears the following "Tested Fair 4/30/13 C. L. H." "12 V." and a word which I cannot read. Will you please state, if you know, what that word is, and what the entire marking means?

A. This shows that this valve was tested on April 30, 1913, and the marking is "12 V. Carbon"; it shows that this valve is a 12-volt carbon filament. Marked "Tested Fair". The signature I cannot make out.

Q. 36. Do you know what the words "Tested Fair" mean on that tag?

A. This means that this valve did not come up to the tests of our standard.

Mr. Cosgrove: Claimant's counsel offers in evidence the Fleming valve last referred to by the witness and requests that the same be marked "Claimant's Exhibit No. 174, Fleming Valve".

The Notary does as requested.

Mr. Cosgrove: Claimant's counsel also offers in evidence the remaining four of the six Fleming valves produced by the witness, and requests that the same be marked respectively "Claimant's Exhibits Nos. 175, 176, 177 and 178, Fleming Valve".

(The Notary does as requested.)

Q. 37. In your former deposition you referred to and produced a receiver marked "Plaintiff's Exhibit No. 28, Fleming ——— Valve Receiver" and stated that it was received in October, 1910, from the British Marconi Company, and that at the time of its receipt it was accompanied by six 12-volt Fleming valves. Can you produce a specimen of the type of Fleming valve which accompanied this receiver when received by you?

A. I can.

Q. 38. Will you please do so?

A. This is one of the type of valves received with the tuner from the British Marconi Company.

(Witness produces "Claimant's Ex. 172, English Fleming Valve").

Q. 39. When did the Marconi Wireless Telegraph Company of America begin to have manufactured for it in this country the Fleming valves, of one or more of the types like "Claimant's Exhibits 173 to 178", inclusive?

A. We began having these valves manufactured in the latter part of 1910 up to 1913, inclusive.

Q. 40. State, if you know, about how many of the various types of Fleming valves you have referred to in your last answer, were manufactured for the Marconi Company from the latter part of 1910 up to 1913, inclusive?

A. We had more than a thousand of these valves manufactured for us, but I have no records to show at the present time just how many, as they are very incomplete.

Q. 41. How do you know that the Marconi Company had [fol. 1063] manufactured for it more than one thousand valves?

A. From the records which I have gone over, which are very incomplete, and the number of valves which I received from the manufacturers it was more than a thousand.

Q. 42. Have you made a search for, and been able to find, any of the records of the American Marconi Company which would show the receipt of Fleming valves and Marconi valve tuners?

A. I have.

Q. 43. What did you find in the way of such records?

A. I have the large receiving book; also bills from the General Electric Lamp Works, and bills of the Tungsten Lamp Repair Company.

Q. 44. Will you please produce the Receiving Book and the bills referred to in your last answer?

A. I produce the books and bills.

Q. 45. What, if anything, did you have to do with the book which you have produced and which has pasted on it a label "Marconi Co. Large Account Book, Book No. 1"?

A. Upon receipt of material it was my duty to check the items as entered, to see that they conformed to the material actually received.

Q. 46. For how long past has this book you have produced been in your possession?

A. This book has practically been in my possession or in the shop at least since 1904.

Q. 47. What periods does this book cover?

A. September 22, 1902 to November 30, 1905; May 18, 1907 to July 15, 1907; December 2, 1910 to December 30, 1912.

Q. 48. Is this the only book that you have been able to find covering the receipt by the Marconi Company of Fleming valves?

A. Yes, this is the only book; I have been unable to find the others.

Q. 49. Have you made an examination of the entries in this receiving book to ascertain the number of Fleming valves and Marconi valve receivers received by the Marconi Company, as shown by the book?

A. I have done so.

Q. 50. Have you made, or had made, a correct transcript from this book of the Fleming valves which were received at the New York City shops of the Marconi Company?

A. Yes, I have had a transcript made.

Q. 51. Will you please produce it?

A. (Witness hands same to counsel.)

Q. 52. Is this transcript a correct copy of the entries from the large receiving book relating to the receipt of Fleming valves?

A. Yes, it is.

Mr. Cosgrove: Claimant's counsel offers in evidence the receiving book produced by the witness, with particular reference to Fleming valves and Marconi valve receivers, and requests that the same be marked "Claimant's Exhibit No. 179, Marconi Receiving Book No. 1".

(The Notary does as requested.)

Mr. Cosgrove: For the convenience of Court and counsel Claimant also offers in evidence the transcript of the entries of the receipt of Fleming valves from this book produced by the witness and requests that the same be marked "Claimant's Exhibit No. 180, Transcript No. 1, Fleming Valves".

(The Notary does as requested.)

Q. 53. How many Fleming valves were received according to the entries in "Claimant's Exhibit No. 179, Marconi [fol. 1064] Receiving Book No. 1" and as shown in the transcript which you have produced?

A. There is a total of 702 valves.

Q. 54. In your answer to Q. 43 you produced five bills of the General Electric Company for the manufacture of Fleming valves. How many Fleming valves do these five bills call for?

A. These five bills show a total of 222 valves in all.

Q. 55. Are these 222 valves included within the 702 Fleming valves previously mentioned by you?

A. Yes.

Q. 56. Please give the dates of the five General Electric bills?

A. December 29, 1911; February 10, 1912; November 16, 1911; November 17, 1911; and February 15, 1912.

Mr. Cosgrove: Claimant's counsel offers in evidence the five bills produced and referred to by the witness, and the same are marked "Claimant's Exhibit No. 181, General Electric Company Bills".

Q. 57. Referring to the bills of the Tungsten Lamp Repair Company for the manufacture of Fleming valves, will you please state how many Fleming valves those bills call for?

A. These bills call for a total of 825 valves.

Q. 58. Are the valves called for by these bills in addition to the 702 valves shown by "Claimant's Exhibit No. 179, Marconi Receiving Book No. 1"?

A. These are in addition to those shown in the book.

Q. 59. In other words, the incomplete records which you have produced show that the Marconi Company had manufactured for it 1527 Fleming valves; is that correct?

A. Yes, 1527.

Mr. Cosgrove: Claimant's counsel offers in evidence the bills of the Tungsten Lamp Repair Company produced by

the witness and requests that the same be marked "Claimant's Exhibit No. 182, Tung ten Lamp Repair Company Bills".

(The Notary does as requested.)

Q. 60. Did the Marconi Company, in addition to manufacturing the Marconi valve receivers, have those receivers manufactured for it by others?

A. Yes, the Electrical Industries Manufacturing Company manufactured a number of these for us.

Q. 61. Does "Claimant's Exhibit No. 179, Marconi Receiving Book No. 1" show the receipt of Marconi valve receivers or tuners received by the Marconi Company during the period covered by that book?

A. No; this does not cover it, only a part,—as we manufactured large numbers ourselves.

Q. 62. What does "Claimant's Exhibit No. 179, Marconi Receiving Book No. 1" refer to in the way of Marconi valve receivers or tuners?

A. That book merely covers the ones manufactured outside of our own shop and also those shown as credits returned from vessels, and so forth.

Q. 63. Have you made an examination of the entries in "Claimant's Exhibit No. 179, Marconi Receiving Book No. 1" to ascertain the number of Marconi valve receivers or tuners received by the Marconi Company as shown by that book?

A. I have done so.

Q. 64. What number of Marconi valve receivers or tuners were received by the Marconi Company according to the entries in this book?

A. A total of 58 valve tuners.

[fol. 1065] Q. 65. Have you made, or had made, a correct transcript from "Claimant's Exhibit No. 179, Marconi Receiving Book No. 1", showing the entries of the receipt of these 58 tuners?

A. Yes, I have done so.

Q. 66. Will you please produce it?

A. (The witness produces transcript.)

Mr. Cosgrove: For the convenience of Court and counsel, Claimant's counsel offers in evidence the transcript just

produced by the witness and requests that the same be marked "Claimant's Exhibit No. 183, Transcript No. 2, Valve Tuners".

(The Notary does as requested.)

Q. 67. What was done with the Fleming valves which the Marconi Company had made for it?

A. We shipped these to our Marconi shore stations and ships for use with the Marconi valve receivers.

Q. 68. What kind of use—was it commercial or otherwise?

A. These were used for commercial purposes for the reception of messages between ship and shore stations and ship to ship stations.

Q. 69. Was any other disposition made by the Marconi Company of these Fleming valves; if so, what was done with them?

A. Yes. We sold them to commercial companies, private individuals and amateurs.

Q. 70. What disposition did the Marconi Company make of the Marconi valve tuners or receivers you have referred to?

A. On receipt of orders from our head office we shipped the Marconi valve tuners to our ship and shore stations; also sold them to commercial companies and individuals.

Q. 71. How do you know that the Fleming valves and Marconi valve tuners were shipped to ship and shore stations for use at those stations?

A. I myself shipped many of these Marconi valve receivers in conjunction with my assistants.

Q. 72. During what years were these Fleming valves and Marconi valve receivers shipped by the Marconi Company to ship and shore stations, commercial concerns and individuals?

A. We shipped the valve receivers from the period of the latter part of 1910 to 1915, and the valves from 1910 until 1915.

Q. 73. Please state, if you know, about how many of the Fleming valves were shipped by the Marconi Company from its New York City shops during the years from 1910 to 1915, inclusive.

A. We shipped a total of 649 valves, as shown by our records. These records, of course, are very incomplete and do not cover the total shipments made by us.

Q. 74. Have you here, and can you produce, the records of the shipments of Fleming valves referred to in your last answer?

A. Yes, I have and can produce them.

Q. 75. Will you please produce such records and state just what the records are? I am referring to any shipping books or other records you have.

A. I produce five shipping books showing shipment of Fleming valve receivers, and valves. I also produce pencil copies of loose sheets made by myself, from shipping books which are at the present time missing. I also produce loose shipping orders taken from shipping order books, covering the shipment of valves and valve tuners.

Q. 76. Will you please state what period is covered by the shipping books which you have produced, and which I notice are marked respectively "Shipping Books 2, 3, 4, 5 and 6"?

A. Shipping Book No. 2, July 10, 1911, to October 4, 1911; Shipping Book No. 3, November 11, 1912, to January [fol. 1066] 9, 1913; Shipping Book No. 4, January 26, to May 25, 1912; Shipping Book No. 5, June 10, 1913, to July 6, 1916; Shipping Book No. 6 (marked "Cash Book"), October 7, 1912, to June 13, 1913.

Q. 77. Have you been able to find any shipping books or shipping records of the Marconi Company after 1915?

A. I have not been able to find any books after that date, as they are missing at the present time.

Q. 78. Did you make a search for them?

A. Yes, I made a search for them and am unable to find them.

Q. 79. What, if anything, did you have to do with keeping these five shipping books that you have produced?

A. I was in touch with these books, as it was necessary for me to see that all material shipped checked up with the entries in the books.

Q. 80. How long have these five shipping books been in your possession?

A. These have been in the shop and in my possession more or less at all times.

Mr. Cosgrove: Claimant's counsel offers in evidence the five shipping books produced by the witness, with particular reference to the entries therein relating to the shipment of Fleming valves and Marconi valve receivers or tuners, and requests that the same be marked respectively "Claimant's Exhibit No. 184, Shipping Book No. 2", "Claimant's Exhibit No. 185, Shipping Book No. 3", Claimant's Exhibit No. 186, Shipping Book No. 4", "Claimant's Exhibit No. 187, Shipping Book No. 5" and "Claimant's Exhibit No. 188, Shipping Book No. 6".

(The Notary does as requested.)

Q. 81. In your answer to Q. 75 you produced pencil copies of loose sheets made by yourself from shipping books which are at the present time missing; when did you make those notes and from what books did you make them?

A. These were copied by me from old shipping books in 1915, but these books at the present time cannot be found; these entries are at least ten years old.

Q. 82. What do the pencil notes refer to?

A. These pencil notes refer to the shipment of Fleming valves and valve receivers shipped to our Marconi shore stations and vessels.

Q. 83. In your same answer you produce some loose shipping orders. To what do these shipping orders refer?

A. These refer to shipments of Marconi valve receivers and Fleming valves to vessels and stations.

Q. 84. State, if you know, where these loose shipping orders came from?

A. These shipping orders were removed by me personally from old shipping books in 1917.

Q. 85. Have you made a search for the books from which these loose shipping orders were taken?

A. Yes, I have made a very thorough search and have been unable to find any of them.

Mr. Cosgrove: Claimant's counsel offers in evidence the loose shipping orders referred to by the witness and re-

quests that the same be marked "Claimant's Exhibit No. 189, Loose Shipping Orders".

(The Notary does as requested.)

Q. 86. Can you state the number of Fleming valves and Marconi valve receivers shipped or disposed of by the Marconi Company as shown by these loose shipping orders [fol. 1067] and your pencil notes that you have referred to?

A. I can; the number of valves in the pencil copies is 63 valves and 5 Marconi valve tuners; in the loose shipping orders, 15 valves and 3 Marconi valve tuners.

Q. 87. Is the number of Fleming valves shipped, according to these loose shipping orders and your pencil notes included within, or in addition to the 649 valves which you previously stated had been shipped by the Marconi Company?

A. They were included in the 649 previously mentioned.

Q. 88. Will you please state the total number of Marconi valve receivers or tuners shipped by the Marconi Company to its ship and shore stations and to commercial companies and individuals from 1910 to 1915, inclusive, as appears by the records you have produced?

A. We shipped a total of 649 valves and 117 valve tuners, as shown by my records.

Q. 89. How do you account for the difference in the number of Fleming valves which the Marconi Company had made for it and the number it shipped and disposed of, according to your records?

A. This is due to the incompleteness of my records at the present time, as many of my shipping books are missing.

Q. 90. Have you had made from the shipping books and other shipping records that you have produced, a correct transcript showing to what vessels the Fleming valves were shipped by the Marconi Company, the names of the vessels and the number of valves shipped to such vessels respectively?

A. I have.

Q. 91. Will you please produce this transcript?

A. I will produce the transcript.

Q. 92. Will you please read this transcript on the record?

A. It is as follows:

Fleming Valves Shipments

Fleming Valves were shipped to the following vessels:

Abangary	6	Dakotan	6
Adeline Smith	6	El Alba	6
Aloha	6	El Secunda	6
Avon	1	Relay	6
Bantu	6	Rescue	6
Borgstad	6	Restorer	18
California	6	St. Louis	2
Cassandra	6	Santa Cruz	6
Chalmotte	6	Surmane	6
Kentra	6	Excelsior	6
Laurentie	2	F. G. Pettibone	6
Lenape	6	Florence	12
Louisiana	2	Freida	6
Maracas	8	Georgian	6
Molke	2	Grendader	3
New York	5	Gulfoil	6
Oceana	5	Hamburg	2
Philadelphia	2	Heroine	6
Corsair	4	Virginia	6
Curytyba	1	Wakiva	6
		Warrior	6

41 vessels with 225 valves

[fol. 1068] Q. 93. You handed me in response to Q. 91 a sheet headed "Fleming Valve Shipments"; will you please explain what this sheet is?

A. This is a copy of the distribution of Fleming valve shipments to Marconi wireless stations, Marconi Division offices and so forth, commercial companies and individuals, of the total number of valves copied from my shipping books.

Q. 94. Will you please read that memorandum on the record?

A. It reads as follows:

Fleming Valve Shipments

Distribution among stations, divisions, companies, etc.:

Marconi Wireless Stations

Cape May, N. J.	7	Siasconsett, Mass.	5
Palm Beach, Fla.	5	So. Wellfleet, Mass.	14
Sagaponack, N. Y.	6	Virginia Beach, Va.	11

Marconi Divisions, Offices, etc.

Cleveland, Ohio	3	New York City, N. Y.	51
Jersey City, N. J.	12	San Francisco, Cal.	78
Montreal, Canada	2		

Commercial Companies

Manila, P. I.	12	Phila., Pa.	8
Hamilton, Ohio	1	Pittsburgh, Pa.	2
Boston, Mass.	4	—, Hawaii	6
Harrison, N. J.	24	New York City, N. Y.	18
Detroit, Mich.	6	New Orleans, La.	26
Guancia Centralle, Porto Rico	12	Santa Marta, Colombia	7
		Swan Id., Honduras	12

Individuals

Albany, N. Y.	1	Chicago, Ills.	3
Atlantic City, N. J.	6	Derby, Conn.	2
Athens, Ga.	2	Elizabeth, N. J.	1
Boston, Mass.	2	Fargo, No. Dak.	1
Burlington, Iowa	1	Fort Worth, Tex.	1
Cambridge, Ohio	1	Harrison, N. J.	1
Chester, Pa.	1		

Q. 95. Please look at the typewritten paper now handed you, and state what that is.

A. This is a copy of the distribution of Fleming valve shipments made from my old shipping books.

Q. 96. Is this a continuation of the previous typewritten sheet you have produced and read from?

A. Yes, it is.

Q. 97. Will you please read that on the record?

A. It is as follows:

[fol. 1069] *Fleming Valve Shipments*

Distribution among stations, divisions, companies, etc. (continued):

Individuals

Ithaca, N. Y.	1	Pulaski, Mich.	1
Lamoni, Iowa	1	Reading, Pa.	2
Lincoln, Neb.	1	Rutland, Vt.	1
Moline, Ill.	1	Salt Lake City, Utah	2
New Orleans, La.	2	Seranton, Pa.	1
New York City, N. Y.	2	Seattle, Wash.	1
Oklahoma City, Okla.	1	Stanislaus, Cal.	1
Orono, Me.	1	Toledo, Ohio	1
Phila., Pa.	1	Watsonville, Cal.	1

Schools, Colleges, etc.

New York City, N. Y.	1	—, So. Dak.	1
Valparaiso, Ind.	1	—, Minn.	1
—, Mont.	2		

Government

New York City, N. Y.	29	Wash., D. C.	3
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Uncertain or Unknown

9

Total 424

Q. 98. Please look at the pamphlet now shown you and state, if you know, what it is.

A. This is a Marconi catalogue showing the various types of apparatus and instruments for amateur purposes.

Q. 99. If you know, will you please state when this catalogue was issued by the Marconi Company?

A. To the best of my recollection this was around the early part of 1913.

Q. 100. Do you find any reference in this catalogue to the Fleming valves; if so, please state the page where the reference is found and read it.

A. I do, on page 6 (Reproduced Opposite); it reads as follows:

"The Fleming Oscillation Valve"

This is the type of detector with which the Marconi Transatlantic reception is accomplished. Operates on four to six dry cells.

Detector complete with base. Price, \$3.50 each. Extra valves, \$2.50 each. Add 10c. for postage."

Mr. Cosgrove: Claimant's counsel offers in evidence page 6 of the catalogue referred to and produced by the witness, and the same is marked "Claimant's Exhibit No. 190, Page 6 of Marconi Catalogue."

Q. 101. Do any of the shipping books you have produced contain any entries relating to the shipment of Fleming valves to the John Wanamaker store in the City of New York; I mean the wireless station at the John Wanamaker store in the City of New York?

A. Yes, these shipping books show numerous entries of valves shipped to the John Wanamaker wireless station in New York City.

[fol. 1070] Q. 102. Will you please read from the shipping books the entries of the shipments of these Fleming valves to the John Wanamaker store in New York City?

A. They are as follows:

Shipments to John Wanamaker's New York Store

Valves

Pencil Copies

<i>Date</i>	<i>Page</i>	<i>Items</i>
April 12, 1913	B-	2 12-volt tungsten valves
May 13, 1913	B-7151	5 12-volt carbon valves

Shipping Book No. 2

July 24, 1911	A-206	1 12-V carbon valve
		1 12-volt tungsten valve G. E. type
July 25, 1911	A-209	2 12-V carbon valves
Sept. 1, 1911	A-258	1 4-vlt. valve
		1 4-vlt. valve sample

Shipping Book No. 4

Feb. 28, 1912	B-857	2 12-V G. E. tungsten valves
Apr. 16, 1912	B-921	1 G. E. Tungsten 12-V valve

Q. 103. Referring to "Claimant's Exhibit No. 186, Shipping Book No. 4", I call your attention to shipping order No. B-857, dated February 28, 1912, being a shipment of two 12-volt G. E. tungsten valves to the Marconi Station, John Wanamaker, New York; also shipping order B-921, dated April 16, 1912, being the shipment of one G. E. tungsten 12-volt valve to the Marconi Wanamaker station, New York. Both of these shipping orders refer to D. Sarnoff. Will you please state what that reference to D. Sarnoff means in these shipping orders?

A. These shipping orders show that the Marconi Company delivered to the Marconi Station, John Wanamaker, New York, two 12-volt G. E. tungsten valves, and they were delivered to D. Sarnoff. The second order, B-921, shows that I personally made out this shipping order for the Wanamaker Station, New York, one G. E. tungsten 12-volt valve and two pieces of quarter inch by five inch copper rod, and the signature is signed by Mr. D. Sarnoff.

Q. 104. What was Mr. Sarnoff doing at this station at that time?

A. Mr. Sarnoff was the wireless operator at the Wanamaker station at that time.

Q. 105. Were the valves in those orders delivered to Mr. Sarnoff?

A. I delivered the B-921 order personally to Mr. Sarnoff according to the record 1 G. E. tungsten 12-volt valve.

Q. 106. To whom were the valves referred to in the order of February 28, 1912 delivered?

A. These two 12-volt valves were delivered to Mr. D. Sarnoff.

Q. 107. Who is the D. Sarnoff referred to in these records?

A. The Mr. D. Sarnoff referred to in these records was the operator at the John Wanamaker store station in New York City, and is now Vice-President and General Manager of the Radio Corporation of America.

Q. 108. State, if you know, with what device or apparatus [fol. 1071] the Fleming valves were first used in this country by the Marconi Wireless Telegraph Company of America?

A. These were used with British Marconi valve receivers shipped to us from England.

Q. 109. I show you two bills; will you please state what these are, if you know?

A. These are bills for 2 Special 6000 foot wave valve receivers Nos. 5015 and 5014; 1 set with two valves only, the other with two valves also, and one pair of high resistance telephones. This bill is dated the 10th of May, 1909. The second bill is for 1 valve receiver with intermediate circuit No. 7434, 4 12-volt carbon valves; 4 12-volt tungsten valves, 2 high tension resistances and 1 telephone transformer No. 6864.

Q. 110. Whose bills are they?

A. These are the bills of the Marconi Wireless Telegraph Company, Limited, Hall Street Works, Chelmsford, showing shipment of these two Special 6000 foot wave tuners to the Marconi Wireless Telegraph Company of America.

Q. 111. Do you know whether or not the valve tuners and valves referred to in these two bills were actually received by the American Marconi Company?

A. Yes.

Q. 112. How do you know it?

A. I received them myself.

Q. 113. When did you receive them?

A. These were received by me in the middle part of the year 1909.

Mr. Cosgrove: Claimant's counsel offers in evidence the two bills referred to by the witness, and the same are marked "Claimant's Exhibit No. 191, British Marconi Bills."

Q. 114. Do any of the valve tuners referred to in either of those bills bear any relation to the type of tuner marked herein "Plaintiff's Exhibit No. 28, Fleming Valve Receiver"?

A. Yes, this long wave receiver No. 5015 is one of the two received by me from England.

Q. 115. Do you know what became of the British Marconi short wave Fleming valve receiver called for in the bills you have produced?

A. When we first received these tuners, we shipped them to various shore stations to be tried out as to their availability to compare with our tuners in use at that time.

Q. 116. Can you produce one of these British short wave tuners?

A. Do you refer to the original tuners?

Q. 117. I do.

A. I cannot produce one of the original of that type at the present time, as I do not know what became of them.

Q. 118. Please look at the photograph now shown you and state, if you know, what it is a photograph of.

A. This is a photograph of the first valve tuners received from the British Marconi Company of England.

Q. 119. Is it a photograph of the first British short wave or long wave valve tuners?

A. This is a photograph of the short wave receiver.

Mr. Cosgrove: Claimant's counsel offers in evidence the photograph identified by the witness and requests that it be marked "Claimant's Exhibit No. 192, Photo of British Short Wave Valve Tuner".

(The Notary does as requested.)

Q. 120. If this photograph shows any Fleming valves, will you please indicate those valves with the letter X on the photograph in black ink?

A. I have done so.

Q. 121. Were any of the British long wave and short wave valve receivers equipped with the Fleming valves used commercially in this country to your knowledge?

A. Yes.

[fol. 1072] Q. 122. How do you know this?

A. On my visit to British vessels in the Port of New York I have seen these mounted in their place on the apparatus table; I have also tried these out to see if they were functioning properly.

Q. 123. Can you state about what year you saw these British valve receivers on British ships in the Port of New York?

A. Between 1911 and 1912.

Q. 124. When did the American Marconi Company first begin to manufacture Marconi valve tuners?

A. We began to manufacture the valve tuners in the latter part of 1910, and continued until 1913.

Q. 125. How do you fix those dates?

A. When we received the Marconi valve tuners from England and gave them a try-out at our stations, they proved so satisfactory, according to reports received at the main office, that we decided to manufacture them ourselves.

Q. 126. How soon after you received the valve tuners from England did the American Marconi Company begin to manufacture Marconi valve tuners?

A. We began the manufacture of these valve receivers in the late Fall of 1910.

Q. 127. I show you a piece of apparatus having a tag marked "Plaintiff's Exhibit No. 101, U. S. Dist. Court, S. D. of N. Y., June 7, 1916. Please state if you recognize this apparatus, and if so, state what it is.

A. This is the American Marconi Valve Receiver manufactured by the American Marconi Wireless Telegraph Company.

Q. 128. Have you any recollection of having seen this particular Marconi valve receiver before?

A. I won't say that I have seen that particular one, but I have seen many others like it.

Mr. Cosgrove: Claimant's counsel offers in evidence the apparatus just identified by the witness and requests that the same be marked "Claimant's Exhibit No. 193, Marconi Valve Receiver or Tuner".

(The Notary does as requested.)

Mr. Cosgrove: Claimant's counsel states that this receiver or tuner is an exhibit in the suit in the United States District Court for the Southern District of New York in the case of the Claimant against the De Forest Company for the infringement of the Fleming patent, and therefore requests counsel for the Government to stipulate that it may remain in the possession of claimant's counsel until the close of the case.

Mr. Edwards: Defendant's counsel states that he has no objection to this being done.

Q. 129. What type of detectors were used with the Marconi valve tuners?

A. The Fleming valves.

Q. 130. Referring to "Claimant's Exhibit No. 193", please state what the sockets on this receiver were used for.

A. These bayonet sockets on this tuner were used for the reception of the valves.

Q. 131. What was the purpose of what appears to be a disk condenser mounted on the left hand side of the top of this receiver?

A. It is an aerial tuning condenser.

Q. 132. What is the purpose of what appears to be a disk condenser on the right hand side of the top of this Marconi valve receiver?

A. This is the condenser for the tuning of the tuned circuit or intermediate circuit.

[fol. 1073] Q. 133. What is the purpose of the knob marked "Aerial Tuning Inductance" mounted on the front of this Marconi valve receiver?

A. That was used for the purpose of tuning the antenna and known as a "tuning inductance".

Q. 134. What was the purpose of the use of the sliding device mounted on the top of this Marconi receiver?

A. That was used for fine selective tuning in conjunction with the tuned circuit.

Q. 135. Just what do you mean by your last answer?

A. I don't quite understand your last question.

Q. 136. What was the sliding contact on the top of the Marconi valve receiver called?

A. This was called a "Billi Condenser".

Q. 137. What is the knob on the right hand side of this Marconi receiver? That is, what function does it perform?

A. This is a loose coupling used in the secondary circuit or tuned circuit to give selective tuning.

Q. 138. What was the purpose of the 3-pole double-throw switch mounted on the top of this Marconi receiver?

A. This 3-pole switch shown on the top of the Marconi receiver in the left hand position was in the aerial circuit or stand-by, and when thrown to the right hand side, was then in the tuned circuit.

Q. 139. I show you a book entitled "Text-Book on Wireless Telegraphy" by Rupert Stanley and call your attention to the illustration Fig. 144, on page 252 of that book. Will you please state, if you know, what the illustration represents?

A. This is an illustration of the British Marconi short wave valve receiver.

Q. 140. How does it compare with "Claimant's Exhibit No. 193, Marconi Valve Receiver"?

A. This Marconi valve receiver is very similar in construction, aside from a few mechanical changes, to the American Marconi valve receiver manufactured by us.

Q. 141. In the same book I call your attention to a diagram 143, page 251. Do you know what that diagram represents?

A. The diagram represents circuits of a Marconi valve receiver, as we had many of these in use for our tuners of the same type.

Mr. Cosgrove: Claimant's counsel offers in evidence pages 250 to 253 inclusive (Reproduced Opposite) of the book referred to by the witness and requests that the same be marked "Claimant's Exhibit No. 194, Extracts from Stanley Book".

(The Notary does as requested.)

It Is Agreed that photostats of these pages may be marked and used in evidence instead of the original pages of the book in question.

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Q. 142. In your answers to questions 134 and 136 you [fol. 1074] state that the Billi condenser was for fine tuning. In what circuit is this condenser?

A. My recollection of this Billi condenser is that it is in the plate circuit of the Fleming valve.

Q. 143. Then, as I understand you, this Billi condenser is for fine tuning in the valve circuit?

A. Yes.

Q. 144. When the three-pole 2-throw switch is in the stand-by position, how do the signals get into the valve circuit?

A. The signals get into the valve circuit through a variable condenser and then through a coupled primary in inductive relation to the secondary.

Q. 145. When the 3-pole 2-throw switch is in the tuned position, how do the signals get into the valve circuit?

A. Through the loose coupling of the intermediate circuit.

Q. 146. Please look at the diagram marked "Defendant's Exhibit V-5" and if you recognize it, state what it represents and what you know about that diagram.

A. This print shows it to be an elementary diagram of a Marconi receiver, and numerous ones of the same kind were sent out by us when we sold valves to the amateurs. It shows them how to hook up the circuit for use with the valve.

Q. 147. Can you state approximately when the first of the diagrams marked "Defendant's Exhibit V-5" was sent out by the Marconi Company?

A. This was somewhere in the early part of 1913, to the best of my recollection.

Q. 148. Were the Marconi valve tuners which were sold in 1910 accompanied by any circuit diagram or diagrams showing the circuit arrangement or hook-up of the tuners?

A. Yes, we sent a diagram with these tuners, of the valve circuit.

Q. 149. Have you any copies of these diagrams?

A. Not at the present time.

Q. 150. Did you ever see any of the Marconi valve tuners manufactured by the claimant herein, and equipped with Fleming valves in commercial use in this country, and if so, where?

A. Yes, I have seen these in use at the John Wanamaker station in New York City and aboard the American Line Steamers New York, St. Paul and Philadelphia.

Q. 151. Do you recollect about when you saw these Marconi valve tuners equipped with Fleming valves in the wireless station in the John Wanamaker store in New York City?

A. To the best of my recollection this was during the period of 1911 to 1912.

Q. 152. Referring to "Claimant's Exhibit No. 184, Shipping Book No. 2", order A-296, October 3rd, 1911, and to the item on that order "J. J. Brennan 3 Hr." What does that mean?

A. This shipping order A-296 shows that we received the report of trouble at the station of John Wanamaker's, New York City, and that I in person went there to make repairs to an A. C. armature.

Q. 153. I call your attention to the same shipping book and to shipping order A-272, dated September 13, 1911; will you please state what type of apparatus is referred to in that shipping order, and if you know, where such apparatus was to be installed?

A. This was a Marconi valve receiver complete with six 4 volt G. E. tungsten valves and two pair of telephone receivers, and was shipped to J. R. Irwin, care of Vaniman, The Inlet, Atlantic City, New Jersey; this was for use on the Airship America.

Q. 154. Do you know whether or not this apparatus was [fol. 1075] installed in the airship America?

A. Only from the report from Mr. Irwin, who was operator of the airship, that it worked very satisfactorily while in use.

Q. 155. Have you had made from the incomplete shipping book and records of the Marconi Company covering the period from 1910 to 1915, inclusive, which you have produced, a correct transcript or copy which will show to what shore stations or other places on land Marconi valve tuners were shipped by the Marconi Company, the number of such tuners and where the shore stations and other places were located?

A. I have.

Q. 156. Will you please produce and read it?

A. I will; it reads as follows:

Marconi Valve Tuner Shipments.

Distribution among stations, divisions, companies, etc.:

Marconi Wireless Stations

Palm Beach, Fla.	1	So. Wellfleet, Mass.	1
Point Judith, R. I.	1	Virginia Beach, Va.	3
Savannah, Ga.	1		

Marconi Divisions, Offices, etc.

Aldene, N. J.	1	Norfolk, Va.	1
Baltimore, Md.	2	Port Arthur, Texas	1
Boston, Mass.	1	San Francisco, Cal.	12
Galveston, Texas	1	Seattle, Wash.	2
Jersey City Shop, N. J.	2		

Commercial Companies

Arizona	1	Newfoundland	1
Manila, P. I.	12	Baltimore, Md.	1
New York City, N. Y.	1	Hawaii	1
Boston, Mass.	2	New Orleans, La.	4
Guánica Central, Porto Rico.	6	Swan Island, Honduras	1

Individuals

Atlantic City, N. J.	1	New York City, N. Y.	1
New Orleans, La.	1	Point Lomas, Cal.	1

Government

Washington, D. C.	1
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Uncertain or Unknown

	3
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Total 58 Tuners.

Q. 157. Have you had made a similar transcript showing the vessels to which Marconi valve tuners were shipped and the names of the vessels and numbers of the tuners?

A. I have.

Q. 158. Will you please produce and read it?

A. I will; it reads as follows:

[fol. 1076] *Marconi Valve Tuners Shipments*

Marconi Valve Tuners were shipped to the following vessels:

Adeline Smith	1	Oceana	1	St. Louis	1
Admiral Dewey	1	Pan American	1	St. Paul	1
Admiral Seelye	1	Philadelphia	1	San Sylvester	1
Aleaza	1	City of Bangor	1	Santa Catalina	1
Aloha	1	City of Rockland	1	Santa Clara	1
Aranmore	1	Clan Murray	1	Santa Cruz	1
Avon	1	Comet	1	Saramaca	1
Bantu	1	Commewijne	1	Sarmame	1
Borgstad	1	Copyrenaime	1	El Vailey	1
Buena Ventura	1	Emiline	1	F. G. Pettibone	1
California	1	El Aiba	1	Finland	1
Cassandra	1	El Secundo	1	Florence	1
John Hooper	1	El Siglo	1	Francisco	1
Kentra	1	Ransome B. Fuller	1	Georgian	1
Laurentic	1	Relay	1	Gulfoed	1
Lenape	1	Rescue	1	Trinidad	1
Maine	1	Richmond	1	Trinidadian	1
Maracas	1	Washington Irving	1	Vesta	1
Wana	1	St. Cecilia	1	Virginia	1
Molke	1				

59 vessels with 59 tuners

Q. 159. It appears from your evidence and the incomplete records of the Marconi Company that you have produced, that that company had over 1,500 Fleming valves manufactured for it; that they shipped over a thousand of these valves to their ship and shore stations and to commercial companies and others during the period from 1910 to 1915, inclusive. It also appears from your testimony

and the records you have produced, that the Marconi Company shipped 117 Marconi valve tuners to its ship and shore stations and to commercial companies and others during the same period. Was that a large or small number of Fleming valves and valve tuners for that period?

A. Yes, that was a very large number for that period, as wireless telegraphy was practically in its infancy in those days.

Q. 160. Did you ever personally use any Fleming valves and if so, for what purpose and under what circumstances?

A. I have tried these out at various times on board ships in the Harbor of New York, to see if they were functioning properly; I have also tried them out in our shop testing out valve receivers at various times.

Q. 161. During what years did you use the Fleming valves or try them out in the valve receivers?

A. It covered a period from 1910 to 1913.

Q. 162. Did you ever use or test any crystal detectors, and if so, for what purpose and under what circumstances?

A. Yes, I have tested out crystals at different times in our shop.

Q. 163. Did you test or use crystals on board vessels in the Port of New York in the ordinary course of your inspection on wireless apparatus on these vessels?

A. No.

[fol. 1077] Q. 164. What was the character of the crystals of the crystal detectors which you tested?

A. Carborundum and cerusite.

Q. 165. In using and testing the Fleming valves and the crystal detectors, what signals did you work with?

A. We used the signals transmitted by some of the stations around the City of New York and vessels.

Q. 166. About when did you make the tests with the crystal detectors?

A. This was around between 1910 and 1911.

Q. 167. In testing and using the Fleming valves and crystal detectors, how did you find they compared in sensitiveness and tuning?

A. The signals from near-by stations, with the crystals and valves were about of equal strength, but on some very weak signals the valves were more sensitive and seemed to tune much sharper than the crystals.

Q. 168. In your experience with the Fleming valves and crystal detectors, how did they compare in reliability?

A. The valves were much more reliable than the crystals, as it was not so easy to knock them out of adjustment, and therefore were more staple.

Q. 169. From your testimony it appears that the Marconi Company was shipping Fleming valves in 1915. Can you state about when that company discontinued the use and shipment of these valves?

A. We discontinued the shipping of these valves in 1915, to the best of my recollection.

Q. 170. Can you give any of the reasons why the Marconi Company discontinued the shipment of Fleming valves?

A. Yes; we found that the valves were very costly on account of the fragile filament and breakage of filaments and bulbs in shipment.

Q. 171. Was there any breakage, to your knowledge, of the filaments or bulbs after they were put into use?

A. Yes, the life of the filament was of very short duration, due to the operators not understanding how to properly take care of them, and they would burn out in a very short while, due to the operators not understanding how to use the same.

Q. 172. What was used in the way of a battery to light the filament of the Fleming valve?

A. We used a storage battery of 6 and 12 volts for use in lighting up the filament of the valve.

Q. 173. Did you find it difficult to educate operators in the use of these batteries, and if so, what were the difficulties?

A. Yes; we found that it was very hard to educate the operators to keep their storage batteries charged up and keep them in condition so that they would properly light the filament.

Q. 174. State, if you know, what was the nature or character of the filaments of the Fleming valves in those early days.

A. The first valves that were in use were a carbon filament, but we found that this was not satisfactory, as after a short while of use with the filament lit up the signals would fade and then we began the manufacture—or had manufactured for us—the tungsten filament, which we found was very satisfactory, as the signal strength remained constant, and did not fade.

Q. 175. I show you a photograph which is "Complainant's Exhibit No. 153" in this case. Please state what that photograph represents, if you recognize it, and who the individuals are pictured in that photograph, if you know.

A. This is a photograph of myself, Mr. Ballam and Mr. Chevelier, showing the interior of the wireless telegraph room and of the apparatus of the S. S. St. Paul, about 1905.

[fol. 1078] Cross-examination.

By Mr. Edwards:

X Q. 176. Did the Marconi Company, at any time provide crystal detectors with holders adapted to fit into the lamp sockets of these Fleming valve receivers?

A. Yes. We began to have manufactured for us at Aldene, New Jersey, in the year 1914, adaptors to be used in the sockets of the Fleming valves.

X Q. 177. Were these crystals with adaptor sockets sent out to the Stations to which the valve receivers had been sent originally?

A. The crystal was mounted in a separate cup from the adaptor and was shipped to our various stations for use with the valve receivers.

X Q. 178. This was about 1914?

A. Yes.

X Q. 179. What was the reason for sending out these crystals.

A. We discontinued the Marconi valves because we found the up-keep of the valves very costly from a maintenance point of view, as the filaments would be broken in shipment and burned out by the operators, through misuse, and therefore we were compelled to adopt some substitute, which was the crystal, to cut our maintenance cost down.

X Q. 180. How long did the use of crystal detectors continue by the Marconi Company?

A. That is, in general, or with the valve receiver?

X Q. 181. Both.

A. We have been continually using crystals since 1914 and, I believe, some are in use at the present time on vessels with various types of tuners manufactured by us.

X Q. 182. When did the Marconi Company begin to use three electrode vacuum tubes?

A. I cannot answer that question, as I am no longer connected with the Marine Division; I am in another depart-

ment entirely separate from it, known as the Sales Service Section.

X Q. 183. Did any of the stations of the Marconi Company employ three electrode vacuum tubes to your knowledge?

A. No.

X Q. 184. Then you have no knowledge of any use of the three electrode vacuum tubes by the Marconi Company?

A. No.

X Q. 185. Have you any knowledge as to how long all or any of the fifty-eight Marconi valve receivers or tuners remained in use?

A. These Marconi valve receivers, to the best of my recollection, were in use on various stations and vessels from the latter part of 1910 and continued in use after 1914 and up to 1916 or 1917, with the adaptor in use with the crystal.

X Q. 186. In the Stanley book, "Claimant's Exhibit No. 194", reference is made to wire gauze shields put over the valves to protect them from static charges. What experience did you have, or have reported to you, concerning the effect of static charges in connection with these Marconi valve receivers?

A. I have never heard any report, to my knowledge, that static had any effect on the Fleming valve.

X Q. 187. Were gauze shields put over the valves in any of the Marconi valve receivers concerning which you have testified here?

[fol. 1079] A. No; only in those valves which were received from the British Marconi Company; some of these had a copper wire gauge shield around the outside, but we did not make use of that shield in our Marconi valve tuners; that is, we never grounded them.

X Q. 178. In operating the valve receivers, was it necessary for the operator to adjust the filament voltage?

A. Yes; in adjusting the filament voltage through a 6-ohm rheostat and then by adjusting a potentiometer of 480 ohms, which was alongside of the rheostat, we found a point where maximum signals were received.

X Q. 179. When this adjustment was arrived at did the operator find it necessary to make readjustments for receiving other stations, or for best reception from the same or different stations?

A. I cannot speak of the use by the operators, only from my own personal experience.

X Q. 180. Will you state your own experience?

A. I found that by varying the rheostat back-and-forth in conjunction with the potentiometer, that there was one point where the signals would be very sharply defined in the head receivers.

X Q. 181. And was this point the same for all wave lengths, distances and stations?

A. That would hold true in regard to the signals received, some being weak and some being strong, but the point would be noticeable just the same, by moving the potentiometer back-and-forth.

X Q. 182. In picking up a station was it not customary to adjust the filament voltage somewhat analogous to adjusting a crystal, until the point of best reception is attained?

A. Yes.

Last Question by the Notary: Do you know of any other matter relevant to this claim?

Answer. I don't recollect any at this time.

Deposition Closed.

It is Hereby Stipulated and Agreed, by and between the attorneys for the respective parties herein, that if John J. Brennan were recalled as a witness on behalf of the claimant herein, he would testify as follows:

1. That from an examination of the incomplete records of the claimant, including Plaintiff's Exhibits No. 186, shipping book No. 4, and No. 187, shipping book No. 5, he finds that the claimant shipped to the defendant, the United States, on or about the following dates, at the following places, the following wireless telegraph apparatus:

January 30, 1912, General Storekeeper Navy Yard, Brooklyn, New York, twelve four-volt Fleming valves.

March 22, 1912, Navy Department Bureau of Steam Engineering, Washington, D. C., One 4-volt Fleming valve.

March 25, 1912, General Storekeeper Brooklyn Navy Yard, five 4-volt Fleming valves for five Marconi valve tuners or receivers.

April 8, 1912, Bureau Naval Supply, account of Navy Yard, Washington, D. C., one Marconi valve tuner or receiver, and two 4-volt Fleming valves.

October 27, 1913, General Storekeeper, Navy Yard, Brooklyn, New York, twelve Fleming valves.

[fol. 1080] 2. That the shipments of valves on January 30, 1912, and March 22, 1912 above referred to, were made on account of contract No. 251, dated December 29, 1911, between the claimant and the defendant, calling for one quenched gap wireless telegraph set complete the receiver to be provided with a valve detector and 12 spare valves.

3. That the shipment of valves above referred to of March 25, 1912, was made on account of contract No. 221, dated January 3, 1912, between the claimant and the defendant, calling for five quenched gap wireless telegraph sets complete, the receiver to be provided with a valve detector and 12 spare valves.

4. That he is unable to state whether or not the shipment above referred to of April 8, 1912, of a valve tuner or receiver and Fleming valves, and the shipment of October 27, 1913, of Fleming valves were made under any contract or contracts between the claimant and the United States.

Claimant's counsel offers in evidence the contracts above referred to, and the same are marked respectively Claimant's Exhibit No. 198, Marconi-Government Contract of December 29, 1911, and Claimant's Exhibit No. 199, Marconi-Government Contract of January 3, 1912.

Deposition of CLARENCE S. RICE, for Claimant, taken at New York, N. Y., on the 29th day of October, A. D. 1925.

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence; whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry; and whether, and in what degree you are related to the claimant.

Answer. My name is Clarence S. Rice; age, 31; residence, 236 South Fifth Avenue, Mount Vernon, New York; occupation, Technician in the National Service Department, Radio Corporation of America, 326 Broadway, New York. I have no interest, directly, or indirectly, in this claim and I am not related in any way to the claimant.

Direct examination.

By Mr. Cosgrove:

Q. 183. How long have you been connected with the Radio Corporation of America, and in what capacities?

A. Since 1919, when the Radio Corporation of America took over the Marconi Wireless Telegraph Company of America, as Chief Radio Operator on ship and shore stations, until 1921.

Q. 184. When did you assume your position as Technician in the National Service Department of the Radio Corporation of America?

A. About September 5th, 1925.

Q. 185. What was your business or occupation between 1909 until 1921?

A. Commercial Wireless Telegraph Operator.

Q. 186. By whom were you employed as such operator during that period?

A. In the early part of 1909 by the Massie Wireless Telegraph Company for a brief period; then by the National Electric Signaling Company; later by the United Wireless Telegraph Company, and then by the Marconi Wireless Telegraph Company of America, and then by the Radio Corporation of America following that.

[fol. 1081] Q. 187. During what period were you employed as a wireless operator by the Marconi Wireless Telegraph Company of America?

A. From 1912 to 1919.

Q. 188. Where were you employed as a wireless operator by the claimant herein (Marconi Wireless Telegraph Company of America)?

A. Various steamships sailing out of New York.

Q. 189. Did you also act as wireless telegraph operator at radio shore stations?

A. Yes, in a relief capacity; by that I do not mean continuous service.

Q. 190. Did the steamships on which you were employed as wireless operator by the claimant herein, include the S. S. Camaguey of the Ward Line?

A. Yes.

Q. 191. During what period did you act as a wireless operator on that steamship?

A. From April, 1914, until January, 1916.

Q. 192. Was there more than one wireless operator on this ship while you acted as an operator on it?

A. Occasionally when we had a full passenger list, two operators were carried.

Q. 193. Was the S. S. Camaguey a freight and passenger vessel?

A. The S. S. Camaguey was rated as a freight steamer provided with accommodations for about twenty-four passengers.

Q. 194. About how many passengers did the vessel usually carry during the period you were an operator on her?

A. Do you desire an average in those two years?

Q. 195. Yes, you might give the average. I mean the usual number of passengers on each trip.

A. Well, it was only seldom that we carried any passengers at all; that is why I asked the question.

Q. 196. Then on most of the trips during the two years you were operator on the S. S. Camaguey you were the sole operator?

A. That statement is correct.

Q. 197. Between what ports did the S. S. Camaguey ply while you were her wireless operator?

A. Between New York and the South Coast of Cuba and all of the principal Mexican ports on the Gulf Coast.

Q. 198. Was the S. S. Camaguey equipped with wireless receiving apparatus, and if so, will you please state generally what type of wireless receiving apparatus she carried while you were acting as her wireless operator?

A. When I joined this steamer she was equipped with the old United Wireless Telegraph Company's type D receiver; later equipped with the same company's improved receiver, being the inductively coupled type E receiver, with carborundum crystal detector, and later she was equipped with the Marconi Company's inductively coupled tuner for use with the Fleming two-electrode valve.

Q. 199. Will you briefly describe the Fleming valve referred to in your last answer?

A. The Fleming valve in physical appearance resembled the ordinary incandescent bulb, except for its having sealed in the same vacuum in which the filament was contained, a metal plate. It was provided with a special base through which contacts were brought out from its different elements.

Q. 200. I show you an article, and if you recognize it, please state what it is.

A. I recognize this article as a Fleming valve similar to that used by myself aboard the steamship Camaguey. (Witness was shown "Claimant's Exhibit No. 172, English Fleming Valve" and identified same.)

Q. 201. I also show you another article, and if you recognize it, state what it is.

A. I recognize this as the Marconi inductively coupled tuner for use with the Fleming valve, which is identical; that is, as to type, used by myself aboard the S. S. Camaguey.

(The article referred to and identified by the witness is "Claimant's Exhibit No. 193, Marconi Valve Receiver or Tuner".)

Q. 202. Did you personally use the Marconi valve tuner equipped with the Fleming valve during the period you were operator on the S. S. Camaguey?

A. Yes, as I was the only operator aboard ship during the time this receiver was used.

Q. 203. For what purposes did you use this apparatus on board the S. S. Camaguey?

A. For commercial wireless telegraph correspondence.

Q. 204. What, if any, press communications did you receive with the Fleming valve and "Marconi Valve Tuner" while you were operator on the S. S. Camaguey?

A. Daily press dispatches were received from Arlington, Va., Miami, Fla., and others; also weather reports and storm warnings from various naval stations.

Q. 205. Was any detector, other than the Fleming valve, furnished with the Marconi valve tuner installed on the S. S. Camaguey while you were operator on that ship, and if so, what type of detector, and how was it adapted to the Marconi valve tuner?

A. Yes; a carborundum crystal mounted on a special adaptor to fit in the Fleming valve socket was provided for use as an emergency detector in case the valve became broken or otherwise useless through accidental cause.

Q. 206. Did you ever use this carborundum crystal detector with the Marconi valve tuner while you were an operator on the S. S. Camaguey?

A. Only experimentally, to compare the sensitivity of the carborundum crystal with the valve detector.

Q. 207. From what shore or coast stations did you receive wireless communications with the Marconi valve tuner and Fleming valve, while you were operator on the S. S. Camaguey?

A. Commercial wireless telegraph communications were received using the Marconi tuner and Fleming valve be-

tween the following points: Sea Gate, New York; Cape May, New Jersey; Virginia Beach, Virginia; Cape Hatteras, North Carolina; Charleston Naval Station, Charleston, South Carolina; Savannah, Georgia; Jacksonville, Florida; St. Augustine, Florida; Miami, Florida; Nassau in the Bahama Islands; Key West, Florida; Havana, Cuba; Tampa, Florida; Progreso, Yucatan; Tampico, Mexico, Vera Cruz, Mexico; Tuxpam, Mexico; Swan Island and New Orleans. That is all that I recall just now.

Q. 208. In your ordinary commercial work under normal conditions with the Marconi valve tuner and the Fleming valve aboard the S. S. Camagney, over what distance were messages received with that apparatus?

A. Between twenty-five to eighteen hundred miles.

Q. 209. What was the distance you received with the Fleming valve and the Marconi valve tuner aboard this ship Camagney under static conditions found in Southern waters?

A. Between seven hundred and nine hundred miles could be relied upon, except in cases of extremely severe static conditions.

Q. 210. What was the power of the transmitters at the stations from which you received messages with the Fleming valve and the Marconi valve tuner, say from five hundred to eighteen hundred miles?

A. To the best of my knowledge the station at Swan [fol. 1083] Island was a high-power transmitter using about 20 Kilo Watt, 500 cycle transmitter; New Orleans using about 10 K.W., 500 cycle. The Marconi stations which I used to route commercial messages and correspondence through were of 5 K.W. power, using a 60 cycle source of current supply with the non-synchronous rotary gap, such as the stations at Cape May, New Jersey; Miami, Florida, and Tampa, Florida.

Q. 211. Can and will you cite any instances which will show the character of the work done by the Fleming valve and the Marconi valve tuner, and the distances covered in such work while you were using such valve and tuner on the S. S. Camagney?

A. I recall work carried on between the Aztec of the Pacific Mail Steamship Company and the steamship Camagney, during which commercial messages were received by me from the Aztec for re-transmission or delivery to American Coast Stations which I was in communication

with, while the Aztec was approximately forty hours from her point of destination, which was Honolulu, my vessel being about twenty-four hours out of Vera Cruz, Mexico. The approximate distance of this communication was four thousand miles. This instance convinced me of the value of the Fleming valve over the carborundum or crystal detectors, because of a direct comparison made between the valve and crystal detectors on account of weakening signals from the distant ship.

Q. 212. How long was the communication carried on between the S. S. Aztec and the Camaguey in the instance referred to in your last answer?

A. From a little before midnight until sunrise in the latitude and longitude in which the Camaguey was located.

Q. 213. Can you cite any other instances which you consider as showing the value of the Fleming valve as a detector?

A. I recall working with Cape May, New Jersey, while in the Gulf of Mexico, an approximate distance of eighteen hundred miles. Also the receiving of distress signals from a vessel whose name I do not recall now.

Q. 214. How far were you from the vessel from which you received the distress signal?

A. To the best of my knowledge about four hundred miles.

Q. 215. While you were aboard the S. S. Camaguey using the Marconi valve tuner equipped with the Fleming valve, did that ship have any reputation for clearing traffic, or what was its reputation in that respect?

A. Yes, the Camaguey was known to many ships in the Gulf and several Coast stations, for her ability to handle traffic through heavy atmospheric disturbances.

Q. 216. For how long a period while you were aboard the S. S. Camaguey did you use the Marconi valve tuner equipped with the Fleming valve in ordinary commercial work?

A. For about seven or eight months.

Q. 217. Can you state between what months and years such use took place?

A. From about April, 1915, to September, 1915.

Q. 218. After the period of this use was another detector or tuner used by you on the S. S. Camaguey?

A. Yes, the Marconi inductively coupled type 106 tuner with crystal detector replaced the Marconi tuner and Fleming valve receiver.

[fol. 1084] Q. 219. Do you know why this replacement took place?

A. I do not.

Q. 220. Do you know by whose order this replacement was made?

A. By the company's order.

Q. 221. What company's?

A. The Marconi Company's.

Q. 222. Did you ever personally see any Fleming valves and Marconi valve tuners in use on any other ships than the S. S. Camaguey, and if so, on what ships and about what date?

A. I have seen several ships equipped with the Marconi tuner and Fleming valve while in Puerto, Mexico and Vera Cruz, during 1915 and 1916; I couldn't give the approximate dates at present; I don't recall exactly what months.

Q. 223. Did you ever see the Fleming valves in use on any British ships, and if so, when and where?

A. On one occasion I visited a British steamer that was equipped with this receiver while laying in port at Brooklyn, New York, in the latter part of 1915.

Q. 224. Do you recollect the name of the ship?

A. I do not.

Q. 225. In your answer to Q. 189 you stated that you acted as wireless telegraph operator at radio shore stations. Did you ever, when acting as such, use or see the Fleming valve and the Marconi valve tuner in use; if so, please state when and where this was.

A. Yes, at the Coast station located at Galveston, Texas, and Tampa, Florida.

Q. 226. What company operated these stations?

A. The Marconi Wireless Telegraph Company of America.

Q. 227. Did you personally use the Marconi valve tuner equipped with the Fleming valve at either one of those stations; and if so, please state at what station, and when you so used that apparatus?

A. I used the Marconi valve tuner and Fleming valve at the Galveston, Texas, station on various occasions while relieving members of the regular staff.

Q. 228. Was the Marconi tuner at the Galveston station equipped with the adaptor and crystal detector you have referred to in one of your answers?

A. Yes.

Q. 229. Did you ever personally use the Marconi valve tuner and the crystal detector?

A. Only experimentally.

Q. 230. What experience have you had in the use of crystal detectors in commercial wireless work, other than as stated in your last answer, and the experience you had with such detectors on the S. S. Camaguey?

A. I used the crystal detector from 1916 until 1921.

Q. 231. From your experience in the use of the crystal and Fleming valve detectors in commercial wireless telegraph work, will you please state how they compared in sensitiveness and reliability?

A. From personal experience I preferred the valve detector because of its permanency of adjustment and ability to stand up under fairly severe atmospheric conditions.

Q. 232. How did the two detectors compare in sensitiveness?

A. I found the valve the more sensitive of the two.

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Cross-examination.

By Mr. Edwards:

X Q. 233. What kind of detector was employed in the type 106 tuner which replaced the Fleming valve tuner?

A. Cerusite.

X Q. 234. Have you ever used crystal detectors other than carborundum and cerusite?

A. No, I have not.

[fol. 1085] X Q. 235. Do you agree that it is generally understood in the radio art that carborundum is the most insensitive of the crystal detectors and that next to carborundum, cerusite is also considered relatively insensitive?

A. In some cases I do agree with this statement relative to carborundum when used in its raw, untested and unmounted state; however, the Marconi Wireless Telegraph Company was particular to see that no untested crystals

were provided for operators' use in their stations; these crystals were mounted in Wood's metal, I believe, and from personal experience I can say that some of them were very sensitive. Cerusite was found to run comparatively uniform in sensitiveness and matched up favorably with carborundum, although its adjustment was not nearly as permanent.

X Q. 236. Did you have any personal knowledge of the steps taken by the Marconi Company in selecting the carborundum crystals for use in its detectors?

A. None other than the fact that these crystals I have mentioned were supplied from our stock rooms in small boxes which were marked "Tested O. K."

X Q. 237. What was the height and character of the antenna on the Camaguey?

A. The height was approximately one hundred feet above water line, four-wire inverted L type.

X Q. 238. That would be considered a good antenna?

A. Yes.

X Q. 239. Do you agree that the distance from which signals can be received depended very largely upon the skill of the operator?

A. To some extent, yes.

X Q. 240. That is to say, some operators with a given installation, would be able to receive messages from greater distances than other operators could receive with the same installation. Is that statement substantially correct?

A. That statement is substantially correct, inasmuch as the intelligent handling of a radio set or any other piece of machinery is dependent upon that machine's efficient operation.

X Q. 241. Did you ever make any comparison with regard to sensitiveness between the Fleming two-electrode valve and a good galena or silicon or other well-known sensitive type of crystal detector?

A. I made no comparison between the Fleming two-electrode valve and the galena or silicon detectors because of the fact that the only crystal detectors we were permitted to use were the carborundum and the cerusite crystals.

‡ Last Question by the Notary: Do you know of any other matter relevant to this claim?

Answer: No, I do not.

Deposition closed.

[fol. 1086] Deposition of DAVID SARNOFF, for Claimant, taken at New York, N. Y., on the 19th day of November, A. D. 1925.

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence, whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and whether, and in what degree, you are related to the claimant.

Answer: My name is David Sarnoff; age 34 years; residence Mt. Vernon, New York; occupation, Vice-President and General Manager of the Radio Corporation of America. I have no interest, direct or indirect, in this claim, except that I own some scrip of the claimant, and am not related in any way to the claimant.

Direct examination.

By Mr. Cosgrove:

Q. 242. How long have you been connected with the Radio Corporation of America?

A. Since its organization in the Fall of 1919.

Q. 243. With what company were you connected from the years 1916 until the Fall of 1919, inclusive?

A. With the Marconi Wireless Telegraph Company of America.

Q. 244. It appears from a deposition given by you and stipulated into this case, that in 1910 you were appointed operator at the Marconi station erected on the roof of the Wanamaker Building in New York City, and that you held that position for about a year. Can and will you please state the dates when you acted as wireless operator at this Wanamaker station?

A. Yes. I was appointed operator at this station on May 22, 1911, instead of in 1910, and continued to act in that capacity at that station until August, 1912.

Q. 245. What was the general character of the wireless communication conducted at this Wanamaker station while you were operator there?

A. Commercial Wireless telegraph communication between ships at sea and with the Wanamaker station in Philadelphia.

Q. 246. What type of wireless receiver or tuner and detector did you use in receiving wireless communications at this Wanamaker station?

A. During the period when I was operator at this station I used exclusively what is known as the Marconi valve tuner and a detector which was known as the Fleming valve.

Q. 247. Please generally describe the Fleming valve.

A. It consisted of a glass bulb somewhat like the incandescent lamp, except that, in addition to the filament, it had sealed within the bulb a metal plate adjacent to the filament, and was provided with leads extending from the filament and plate to the outside of the bulb.

Q. 248. If you recognize the article handed to you, state what it is.

(Witness handed "Claimant's Exhibit No. 173, Fleming Valve".)

A. It is a Fleming bulb similar to those I used at the Wanamaker Station in New York City.

Q. 249. Please look at Claimant's Exhibit No. 193, and [fol. 1087] if you recognize it, state what it is.

A. I recognize this as a wireless receiver similar to the Marconi valve receiver used by me with Fleming bulbs during the period I acted as operator at the Wanamaker station in New York City.

Q. 250. From your experience in the use of the Fleming valve, how efficient did you find it in commercial radio work?

A. I found the Fleming valve more sensitive and efficient in radio work than the magnetic or carborundum crystal detectors which I had also used.

Q. 251. Can and will you refer to any instance in your personal experience illustrating the character of the work done with the Fleming valve while you were an operator at the Wanamaker station in New York City?

A. Yes; I received radio messages at that station with the Fleming bulbs under difficult and trying circumstances

at the time that the steamship "Titanic" ran into an iceberg in April, 1912.

At the time of this disaster I was on duty as a radio operator at the Wanamaker station in New York City practically continuously for 72 hours, and during that period I was in direct radio communication with all the ships that were rushing to and about the scene of the disaster, and I directly received, without difficulty, their radio messages at such station with the two-electrode Fleming bulb referred to.

Notwithstanding the fact that many were working wireless apparatus in an attempt to get in touch with ships which might be near the scene of the disaster, I was the first to receive, and to receive directly with this two-electrode Fleming bulb, the confirmation from the steamship "Olympic" of the report that the "Titanic" had been sunk. I also received radio messages directly with this two-electrode Fleming bulb from the rescuing ships having aboard survivors from the "Titanic", including lists of the names of survivors.

Q. 252. Approximately how many miles was the Olympic and other ships from the Wanamaker station at the time you received the messages and reports from them referred to in your last answer?

A. Approximately 1,200 or 1,400 miles from New York.

(No cross-examination.)

Last question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

Deposition closed.

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It is hereby stipulated and agreed, by and between the attorneys for the respective parties herein, that if David Sarnoff were recalled as a witness on behalf of the claimant, he would testify as follows:

That the claimant herein, Marconi Wireless Telegraph Company of America, has at all times borne true allegiance to the Government of the United States, and has not in any way voluntarily aided, abetted, or given encouragement to rebellion against the Government of the United States.

[fol. 1088] Deposition of CHARLES J. WEAVER, for Claimant, taken at New York, N. Y., on the 20th day of November, A. D. 1925.

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence, whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and whether, and in what degree, you are related to the claimant?

Answer: My name is Charles J. Weaver; occupation, Traffic Superintendent of the Radio Corporation of America; my age is 53; residence, 150 Beaumont Street, Manhattan Beach, New York; I have no interest, direct or indirect in the claim which is the subject of inquiry, and I am not related in any degree whatever to the claimant.

Direct examination.

By Mr. Cosgrove:

Q. 253. How long have you been connected with the Radio Corporation of America, and in what capacity?

A. Since 1919, as Assistant Superintendent and Superintendent of Traffic.

Q. 254. What is the nature of the Radio Corporation of America's business in which you are engaged?

A. Trans-Atlantic communication by radio.

Q. 255. Have you ever had any experience as a wireless telegraph operator?

A. Yes.

Q. 256. For how long a time did you act as a wireless telegraph operator?

A. From 1903 to 1917 as an operator and station manager.

Q. 257. By "station manager", you mean manager of a wireless station?

A. Yes, manager of a wireless coast station.

Q. 258. For what company did you act as wireless telegraph operator and station manager?

A. Marconi Wireless Telegraph Company of America.

Q. 259. Did you ever serve as a wireless telegraph operator on the steam yacht Atalanta?

A. Yes.

Q. 260. During what period did you act as an operator on this yacht?

A. From May, 1910, to September, 1911.

Q. 261. What type of receiving apparatus was installed on the Atalanta and used by you during the period you served as an operator on that vessel?

A. Marconi tuner fitted with the Fleming valve. We also used a magnetic detector for short-distance work.

Q. 262. What sort of a device was the Fleming valve which you used on the Atalanta?

A. It was an evacuated glass tube similar to an incandescent lamp with a filament and surrounded by a cylinder of platinum.

Q. 263. Did the valve have any terminals extending through the tube?

A. Yes, at the top.

Q. 264. I hand you two devices and if you recognize them, state what they are?

A. That looks like the Fleming valve as near as I can remember it; (referring to "Claimant's Exhibit No. 173, Fleming Valve"); this one, I know what it is, but I never used it (referring to "Claimant's Exhibit No. 172, English Fleming Valve").

[fol. 1089] Q. 265. When did you first see a Fleming valve in use?

A. When I joined the Atalanta, in May, 1910.

Q. 266. Was the tuner fitted with the Fleming valve installed on the Atalanta when you joined that vessel?

A. Yes.

Q. 267. During the period that you acted as an operator on the Atalanta, in whose and what service was that vessel engaged?

A. Mr. George J. Gould, her owner, cruising in foreign waters.

Q. 268. For what kind of work was the valve tuner and Fleming valve used on the Atalanta by you?

A. For the reception of private and press messages, by wireless.

Q. 269. Will you name some of the wireless stations from which you received messages with the tuner and the Fleming valve while you were aboard the Atalanta?

A. Sea Gate, New York; Sagaponack, New York; Siasconset, Massachusetts; South Wellfleet, Mass.; Cape Sable and Sable Island, Nova Scotia; Cape Race, Newfoundland;

Crook Haven Island, The Lizard and St. Catherine's Point and Poldhu, England; Ushant, Marseilles, France; Venice and Messina, Italy; Algiers; I think that will cover the most of them.

Q. 270. In using the valve tuner and Fleming valve on the Atalanta, what was the range or distance from which you received messages?

A. In the day time approximately two hundred and sixty miles; at night, on the ship's or shorter-wave, approximately seven hundred miles; with the longer wave, between fifteen hundred and two thousand miles.

Q. 271. State if you recollect the circumstances under which you received messages, either private, commercial or press, from a distance of one thousand or more miles, while using the tuner and Fleming valve aboard the Atalanta.

A. I received press dispatches from South Wellfleet, Mass., up to Wednesday night after leaving New York the previous Saturday morning, the ship's cruising speed being about fifteen knots per hour. On several other occasions I received press messages from Poldhu, England, and while in the Mediterranean, off the Island of Malta.

Q. 272. If you recollect, will you please state how long a period you received the press messages from South Wellfleet, Mass., and from Poldhu, England, which you have referred to in your last answer?

A. I should say for approximately six months, every night.

Q. 273. Can you estimate and give us the number of words you received with the valve tuner and the Fleming valve while you were acting as an operator on board the Atalanta?

A. Approximately one hundred thousand words; I would estimate this as received within about an hour every night, at a speed of sixteen to eighteen words a minute; that is about as near as I can remember.

Q. 274. When you left the service of the Atalanta, was the tuner fitted with the Fleming valve still in use on that ship?

A. The ship went out of commission and all apparatus was closed up by myself, or covered up.

Q. 275. After you left the Atalanta, where did you next [fol. 1090] serve as a wireless operator?

A. On Colonel Astor's yacht, the Noma, during his honeymoon trip to the Bermudas.

Q. 276. During what period were you acting as an operator on the Noma?

A. Late September until November, 1911.

Q. 277. What type of wireless receiving apparatus did you use while aboard the Noma?

A. Marconi tuner fitted with the Fleming valve.

Q. 278. What was the character of the messages received with this tuner and Fleming valve aboard the Noma?

A. Private messages.

Q. 279. After you ceased acting as an operator on the Noma, where did you next serve as a wireless operator?

A. Rejoined the American Liner Philadelphia.

Q. 280. When and for how long a time did you act as an operator when you rejoined the Philadelphia?

A. From the end of November, 1911, to the end of July, 1912.

Q. 281. In what service was this vessel engaged during that period?

A. Passenger service between New York and Cherbourg and Southampton.

Q. 282. What type of wireless receiving apparatus did you use when acting as an operator aboard the steamship Philadelphia from the end of November, 1911, to the end of July, 1912?

A. The Marconi tuner fitted with the Fleming valve and magnetic detector.

Q. 283. Which of the detectors, the magnetic or the Fleming valve, was normally used by you on the Philadelphia?

A. Both were used.

Q. 284. What was the character of the messages or work done with the Marconi valve tuner and Fleming valve from the end of November, 1911, to the end of July, 1912, on the Philadelphia?

A. Official ship's messages, private messages and press messages.

Q. 285. Which apparatus was used for long distance work aboard the Philadelphia?

A. At the time I was on the Philadelphia the American Line did not subscribe for long distance press dispatches; therefore it was not necessary to receive from either South Wellfleet or Poldhu.

Q. 286. What was your experience when using the Fleming valve aboard the Philadelphia?

A. The Fleming valve installed on the Philadelphia I found not as efficient as the one that I used on the Atalanta, and it was only slightly better than the magnetic detector until I borrowed two valves, previously used on the Atalanta, which increased the signals two-fold, making the valve far superior to the magnetic detector.

Q. 287. For how long a period did you use the borrowed Fleming valves on the Philadelphia?

A. For one voyage only.

Q. 288. Was that voyage the end of your service on board the Philadelphia?

A. Yes, I made a report on my findings to the Company, and as I did not go to sea again in the capacity as an operator, I never had a chance to make any further tests with the Fleming valve.

Q. 289. Did you ever make any comparison as to sensitiveness or reliability between the Fleming valve and any crystal detectors?

A. None whatever.

[fol. 1091] Q. 290. Please look at the apparatus now shown you, and if you recognize it, state what it is.

A. Yes, that is a Marconi tuner similar to what I used on the Atlanta, Noma and Philadelphia (referring to "Claimant's Exhibit No. 193, Marconi Valve Receiver or Tuner"). This exhibit is the same size as the one on the Noma and Philadelphia; but the one on the Atalanta was slightly smaller in build; I am stating this from memory, I am not saying it is so.

Cross-examination.

By Mr. Edwards:

X Q. 291. Did the Atalanta have any detector device other than the Fleming valve?

A. Yes, the magnetic detector.

X Q. 292. Did you use it?

A. Yes, when close in-shore.

X Q. 293. Did she have a crystal detector?

A. No.

X Q. 294. What if any other detecting device was used on the Noma?

A. None.

X Q. 295. That is, none other than the Fleming valve?

A. None other than the Fleming valve.

X Q. 296. Did the Philadelphia have a crystal detector?

A. Not in my time.

X Q. 297. Have you a copy of the report which you made to the company concerning the performance of the Fleming valve on the Philadelphia?

A. No. It was just made in a rough note. In those days we did not go into lengthy reports, just scribbled it down.

X Q. 298. In what circuit did you use the Fleming valve on the Atalanta, Noma and Philadelphia? That is to say, in what kind of electrical connection or circuit diagrams?

A. I can't remember.

X Q. 299. Could you make a sketch of the diagram or hook-up in which you used the Fleming valve?

A. No; not at the present time.

X Q. 300. Did you use a battery for the filament current of the valve?

A. Yes.

X Q. 301. Were any batteries used other than the battery or batteries for lighting the filament?

A. No.

X Q. 302. When you brought the two valves from the Atalanta to the Philadelphia, and increased the signals twofold, how did you measure this increase in signal strength?

A. By making a comparison between the tubes already installed on the Philadelphia and the tube valves borrowed from the Atalanta.

X Q. 303. What did you do to make the comparison?

A. When I heard a ship or shore station with very weak signals on the valves belonging to the Philadelphia, for comparison purposes I changed over to my borrowed tubes.

X Q. 304. How do you know that the borrowed tubes gave signals twice as strong as signals from the Philadelphia tubes?

A. Because I received them.

X Q. 305. Did you have any other way of measuring the increase in signal strength than by listening and estimating the increase?

A. None whatever.

X Q. 306. Then when you say that the signals increased twofold, you mean that it is your present-day recollection that the signals which you heard with the Atalanta valves

[fol. 1092]: were twice as strong as those which you heard from the Philadelphia valves. Is that correct?

A. Yes.

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Last question by the Notary: Do you know of any other matter relative to this claim?

Answer. No.

Deposition Closed.

Deposition of ALEXANDER E. REOCH, for Claimant, taken at New York, N. Y., on the 20th day of November, 1925.

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First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence, whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and whether, and in what degree, you are related to the claimant.

Answer. My name is Alexander E. Reoch; age, 41 years; residence, 94 Elliott Place, East Orange, New Jersey; occupation, Assistant Chief Communication Engineer of the Radio Corporation of America; I have no interest, direct or indirect, in this claim, and I am not related in any way to the claimant herein.

Direct examination.

By Mr. Cosgrove:

Q. 308. How long have you been with the Radio Corporation of America and in what capacities?

A. Since the date of its formation in 1919, in the capacities first, Plant Engineer; second, Assistant Chief Engineer; third, Assistant Chief Communication Engineer.

Q. 309. By communication, do you mean radio communication?

A. Sometimes.

Q. 310. Is most of your work in the radio field?

A. Yes.

Q. 311. Prior to 1919, what work were you engaged in, and for what company?

A. I was engaged in radio engineering work from 1902 to 1919. 1902 to 1905, with the English Marconi Company;

1905 to 1917, with the Canadian Marconi Company; 1917 to 1919, with the American Marconi Company.

Q. 312. Where were you employed and in what capacity, from December 1908, to May, 1909?

A. At the Glace Bay Station of the Canadian Marconi Company, as Assistant Radio Engineer.

Q. 313. Was this a Trans-Atlantic wireless station?

A. Yes.

Q. 314. During the period you were employed at the Glace Bay Trans-Atlantic station was there any other Trans-Atlantic wireless station in North or South America, to your knowledge?

A. There was not.

Q. 315. During the period you were employed at the Glace Bay Station, did you ever act as a wireless telegraph operator, and if so, under what circumstances?

A. During the whole of the period I supervised the performance of the wireless telegraph operator on duty during my watch, which was eight hours daily, and occasionally, in cases of emergency, performed the duties of wireless telegraph operator.

Q. 316. What was the character of the messages you received at the Glace Bay station while acting as an emergency operator, and from where were they received?

A. The messages were ordinary business or press messages for delivery in Canada or the United States; they originated in the British Isles and were transmitted by the wireless telegraph station at Clifden, Ireland.

Q. 317. What type of receiving apparatus and detector did you use in receiving these Trans-Atlantic wireless messages at Glace Bay from Clifden, Ireland?

A. The receiving apparatus consisted of an elevated antenna and ground and tuned circuits, and the detector was the two element Fleming valve.

Q. 318. Will you describe the Fleming valve referred to in your last answer?

A. The Fleming valve consisted of an evacuated glass vessel with a filament contained therein, which could be heated to incandescence by an electric current, and a metallic plate held in close proximity to the filament with a connection brought from the plate through a seal in the glass to the outside.

Q. 319. I show you some exhibits in this case and ask you if you can pick out from them any that resembled the Fleming valves used by you at the Glace Bay station?

A. This one very closely resembles the Fleming valves used at the Glace Bay station, but is somewhat larger in size (witness refers to "Claimant's Exhibit No. 172, English Fleming Valve").

Q. 320. During the period you were at the Glace Bay station, how extensively was the Fleming valve used in receiving wireless messages from the Clifden, Ireland?

A. Entirely.

Q. 321. How satisfactory was the Fleming valve in this transatlantic work?

A. It made a reception possible during the major portion of the day at times at speeds as high as 40 words a minute.

Q. 322. Can you approximate the number of messages received at Glace Bay from Clifden, Ireland, using the Fleming valve during the period you were at that station?

A. I would estimate roughly some 5000 messages, many of which were long press dispatches for the New York Times.

Q. 323. Can you state now how many of these messages were actually received by you personally?

A. About 50 or 100.

Q. 324. By whom were the other messages received?

A. By the three wireless telegraph operators who did 8 hours' watch each per day.

Q. 325. Do you recollect their names? If so, please give them.

A. I remember the names of three who were there most of this time. They were Samuel Currie, Gordon Rabbits and Walter Gray.

Q. 326. What was the approximate distance between the Glace Bay station and the Clifden, Ireland station?

A. About 2300 miles.

Q. 327. When you left the Glace Bay station was the Fleming valve still in use there in transatlantic work?

A. Yes.

Q. 328. Do you know if the Canadian Government owned or operated a wireless station at Cape Race and Cape Ray Canada?

A. The Canadian Government owned wireless telegraphic stations at Cape Race, Newfoundland, and Cape Ray, Newfoundland. These stations were operated for the Canadian Government by the Canadian Marconi Company.

Q. 329. By whom was the wireless apparatus installed in these two Canadian Government stations and about when was it installed, if you know?

A. The apparatus was installed by the Canadian Marconi Company in about 1905, and was enlarged by the Canadian Marconi Company about 1907.

Q. 330. What, if any, connection did you have with designing or installing, or using the wireless apparatus at these two Canadian Government stations?

A. I had nothing to do with the design or installation of the apparatus, but observed the use of the apparatus while stationed at Cape Ray for short periods during 1906 and 1907, and by inspections of the stations which I made in 1908 and subsequently.

Q. 331. What type of wireless receiving apparatus and including detectors was installed and used at the Cape Ray and Cape Race Canadian Government stations?

A. The original installations included Marconi coherer and Marconi detector receivers with the usual grounded antenna system, and the two element Fleming valve receiver was added when the stations were enlarged.

Q. 332. Do you remember about what time the Fleming valve was added to these stations?

A. About 1907.

Q. 333. Why was the Fleming valve added to the equipment of these two Canadian Government stations?

A. Because it was desired that they should communicate between one another and it was impossible to do this with the other types of receiving apparatus.

Q. 334. Why was it impossible to communicate with the other apparatus?

A. It was not sufficiently sensitive.

Q. 335. Will you please state what the distance was between these two Canadian Government stations, and whether it was over land or water?

A. The distance was about 250 miles, about half over land and about half over water.

Q. 336. At the time the Fleming valve was used at these two Canadian Government stations, what was the character of the service these stations was engaged in?

A. Communication between these stations consisted in the transmission of weather reports, fog and ice reports and steamship reports for the Canadian Government Signal Service.

Q. 337. Did the Canadian Government own any wireless stations on the Great Lakes in which the Fleming valves were used?

A. Yes; the two-element Fleming valve was used at stations located at Midland, Tobermory and Sault Ste. Marie, all in the Province of Ontario.

Q. 338. Can you approximate the dates when the Fleming valves were used at these stations?

A. Stations were constructed in 1912 and the Fleming valve was used at that time and during 1913 and 1914 also.

Q. 339. Please look at the apparatus now shown you and if you recognize it, state in a general way what it is. (Witness shown Claimant's Exhibit No. 193.)

A. The apparatus is a two-element Fleming valve, detector and tuner of the type that was being manufactured by the American Marconi Company about 1910.

Q. 340. How do you know this?

A. I handled several sets of this description for the Canadian Marconi Company when I was acting as Chief Engineer for that company, which sets had been purchased from the American Marconi Company and the general handiwork of the instrument made it possible to recognize it as of their manufacture.

Cross-examination.

By Mr. Edwards:

X Q. 341. Was any other type of detecting apparatus besides the two-element Fleming valve employed at any of these Canadian stations to which you have referred in your direct examination, during the time these stations were under your observation?

A. Yes. The Marconi coherer, the Marconi magnetic detector, carborundum crystals and three-element Fleming valves.

X Q. 342. Which of these types of detectors, other than the Fleming two-element valve, were employed at each of the stations named by you and during what periods?

A. The Glace Bay station, during the period I was stationed at that point, had installed a Marconi magnetic detector, which I tested several times, but which was never used commercially. At the Cape Ray and Cape Race stations the coherer receiver was used occasionally in the early years. The magnetic detector was used regularly for short

distance communication. At the Midland, Tobermory and Sault Ste. Marie stations, to the best of my recollection the magnetic detector was also installed, in which cases it would be used for short distance communications. No other receivers were employed at any of these points until about 1911, when we commenced to use crystals at Glace Bay and 1912 when we commenced to use three-element Fleming valves at Glace Bay, and until 1914 when we commenced to use crystal detectors at Cape Ray, Cape Race and the Ontario stations.

X Q. 343. When was the use of the two-element Fleming tube discontinued at each of these stations?

A. At or about the date when the crystal detectors were first installed.

Redirect examination.

By Mr. Cosgrove:

R. D. Q. 344. Were you at Glace Bay in 1911?

A. To the best of my recollection I made one short visit to Glace Bay in 1911.

Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

Deposition closed.

[fol. 1096] *Deposition of Edwin M. Hartley, for claimant, taken at New York, N. Y., on the 25th day of November, A. D. 1925.*

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence, whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and whether, and in what degree, you are related to the claimant.

Answer: My name is Edwin M. Hartley; occupation, Manager of Service Station, Radio Corporation of America, 326 Broadway, New York City; my age is 30; residence 14602 130th Avenue, South Ozone Park, Queens County, Long Island, N. Y.; I have no interest either direct or indirect in this claim; I am related in no way to the claimant.

Direct examination.

By Mr. Cosgrove:

Q. 345. For how long have you been employed by the Radio Corporation of America, and in what positions?

A. I have been employed by the Radio Corporation of America since January 16, 1920 to the present date, and from January 16th, 1920 to March 1st, 1922, District Manager of the Marine Department, Philadelphia. From the first of March, 1922 to November the first, 1924, I was Assistant Superintendent, Maintenance, Repair and Inspection Department, 326 Broadway, New York City. From the first of November, 1924 to the present time in charge of the Sales Service Division of the Sales Department at 326 Broadway.

Q. 346. Did you work for the Radio Corporation of America with relation to radio communication and radio apparatus, generally speaking?

A. Yes, it related to radio communications in so far as ship communication is concerned, and the maintenance of the equipment aboard vessels controlled by the Radio Corporation of America and its affiliated companies.

Q. 347. In whose employ were you between 1912 and 1920, and in what capacities?

A. In 1912, from May 19, 1912 to April 6, 1917, I was employed by the Marconi Wireless Telegraph Company of America as wireless telegraph operator. From April 7, 1917 until Jan. 15, 1920, I was in the United States Navy, with the exception of the last five months, when I was employed in the Philadelphia Navy Yard as radio laboratorian.

Q. 348. While you were in the employ of the claimant, did it maintain and operate a wireless telegraph station at Virginia Beach, Virginia?

A. It did.

Q. 349. Were you ever employed as a wireless telegraph operator at that station, and if so, at about what period?

A. I was, from about November 5, 1913, until June 5, 1914.

Q. 350. State in general what types of wireless receiver and detector were used by you while you served as an operator at this Virginia Beach wireless station.

A. I used the Marconi Company's coupled circuit receiver, commonly known as a Marconi valve tuner, together

with the Fleming two-electrode valve as the main detector and the carborundum detector as the auxiliary.

Q. 351. Will you describe in a general way the Fleming [fol. 1097] valve referred to in your last answer?

A. The Fleming two-electrode valve consisted of an evacuated bulb, into which had been placed a filament, together with a plate adjacent to the filament or a cylinder entirely around the filament, with leads protruding from the bulb.

Q. 352. If you recognize the device shown you, will you state what it is?

A. It is a Fleming two-electrode valve, similar to the type which we used at the Virginia Beach station. (Witness shown Claimant's Ex. No. 177, Fleming Valve.)

Q. 353. I also show you a piece of apparatus and if you recognize it, state generally what it is.

A. It was one of the Marconi Company's coupled circuit receivers with which the Fleming valve was used.

Q. 354. How does it compare with the receiver used by you while acting as an operator at the Virginia Beach station?

A. Its general appearance is identical with that receiver which we used at Virginia Beach.

Q. 355. Were you familiar with the circuits of the receiver used by you at Virginia Beach, and how did you become familiar with them?

A. I was familiar with the circuits as used in this receiver and became familiar with the circuits at various times when it became necessary to make minor repairs. In order to facilitate this work a schematic diagram had been furnished to the station.

Q. 356. I show you Defendant's Exhibit V-5 and ask how this diagram compares, according to your recollection, with the schematic diagram referred to in your last answer?

A. This diagram is essentially a schematic diagram of the receiver, and the circuit is fundamentally the same as the circuit within the receiver.

Q. 357. When you arrived at Virginia Beach station to serve as a wireless operator there, was the Marconi tuner, fitted with the Fleming valve, installed and in use at that station?

A. Yes, a number of Fleming valves had previously been supplied to the station for use with this receiver.

Q. 358. What was the character of the wireless work for which you used the Marconi tuner and Fleming valve, while you were an operator at the Virginia Beach station?

A. For general commercial work, with ships at sea, with the Cape Hatteras station, and included press messages, position reports, S. O. S. calls, and general ship's business between the vessels and their owners.

Q. 359. What company operated the Cape Hatteras station?

A. Marconi Wireless Telegraph Company of America.

Q. 360. In your personal experience with the Marconi tuner fitted with the Fleming valve, what was the range in miles covered in receiving wireless messages?

A. Our average working range was approximately 250 miles during daylight hours, and 1200 miles at night.

Q. 361. In your answer to Q. 350 you referred to a carbondum detector as an auxiliary detector. Just what do you mean by that?

A. The auxiliary detector in this case was used mostly for short distance work and was also kept handy in case we should have at any time trouble with the valves. It was the policy of the company to furnish auxiliary detectors and other auxiliary equipment for use in emergency.

[fol. 1098] Q. 362. What distance do you have in mind by "short distance work"?

A. Short distance work at Virginia Beach was approximately within the radius of 75 miles.

Q. 363. In your use of the Fleming valve and carbondum detector at Virginia Beach, how did they compare in sensitiveness, reliability and general usefulness?

A. The Fleming valve detector was not only more sensitive, but was more stable in operation, in that it did not require adjustments after each time the transmitter had been in operation and did not require frequent adjustments during heavy atmospheric conditions.

Q. 364. What effect did the operation of the transmitter have on the crystal?

A. The transmitter caused the crystal detector to become out of adjustment whenever it was used, and it was necessary to readjust the crystal each time before reception could be had.

Q. 365. In using the Fleming valve with the Marconi tuner at Virginia Beach, was a battery employed, and if so, what was the voltage of the battery?

A. Yes, the filament lighting battery was employed. The voltage ranged from 4 volts to approximately 15 volts, according to the type of tube in use.

Q. 366. In using the Fleming valve at Virginia Beach was any voltage or potential placed on the plate of the valve?

A. Yes, this potential was taken from the filament lighting battery and regulated by means of a potentiometer.

Q. 367. What are the two sliding devices on one end of the Marconi valve tuner Claimant's Exhibit No. 193, and what was the function of these devices?

A. The upper device, containing the heavy wire, was known as the filament voltage regulator, and served to regulate the voltage being supplied to the filament. The lower device containing the fine resistance wire, was known as the potentiometer, and regulated the voltage supplied to the plate of the valve from the filament battery.

Q. 368. Was the Marconi receiver fitted with the Fleming valve in use at the Virginia Beach station when you ceased to act as an operator at that station?

A. It was.

Q. 369. Have you ever seen the Fleming valve in use at any wireless telegraph station other than the Virginia Beach station, and if so, please state what stations, and when you saw it installed at such stations?

A. Yes, I have seen Fleming valves used at the John Wanamaker station at Philadelphia; the Marconi station at Baltimore, Md., and the Marconi station at Savannah, Georgia, during periods in 1915 and 1914, to my best recollection.

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Cross examination.

By Mr. Edwards:

X Q. 370. In operating the Fleming valve, was it necessary, in order to get the best reception, to adjust the filament voltage and the potentiometer to adjust the plate voltage?

A. It was necessary to adjust the potentiometer to obtain the plate voltage, but it was not necessary to adjust the filament regulator to do this.

X Q. 371. Was the potentiometer the same for all incoming signals?

A. The potentiometer adjustment was the same for all incoming signals during a certain period. I mean by that [fol. 1099] it was not necessary to readjust the potentiometer for each individual signal, but could be left with one adjustment for a considerable period of time.

X Q. 372. Was it customary each time the set was put in operation to adjust the potentiometer?

A. It was not necessary to adjust the potentiometer after each time the transmitter had been in operation and the receivers put back in use.

X Q. 373. If the set stood idle for a time, was it customary to adjust the potentiometer at the time the set was put back into use?

A. If the battery being used had the same voltage it would not be necessary to readjust the potentiometer. However, any fluctuation in battery voltage would require a readjustment.

X Q. 374. It is true, is it not, that the batteries in use run down, and that as they did run down it was customary to readjust the potentiometer in accordance with the reduction in battery voltage?

A. Large sized storage batteries were in use and the voltage remained almost constant for a considerable period of time, thereby requiring but few readjustments.

X Q. 375. What period of time do you refer to as a "considerable period"?

A. During a normal watch which was of 8 hours' duration.

X Q. 376. When you state in answer to Q. 365 that the filament voltage ranged from 4 volts to approximately 15 volts, does this mean that different voltages were selected for different tubes?

A. Tubes employing the same length of filament wire required the same voltage, and the voltage used was entirely due to the type of tube in use, of which we had three different types.

X Q. 377. What voltage was used with each type?

A. One type, as exhibited, used, to the best of my knowledge, from 4 to 6 volts, and we had two other types, one using in the neighborhood of 10 volts and the other around 15.

X Q. 378. How was the voltage adjusted for each type of tube?

A. By means of a switching arrangement external to the receiver, together with a filament regulator on the receiver.

X Q. 379. Was it necessary to adjust the filament voltage each time a new tube was put in the set?

A. Each new type of tube would naturally require a different adjustment on the voltage regulator; but tubes of one type were fairly constant.

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Redirect examination.

By Mr. Cosgrove:

R. D. Q. 380. What were the differences in the three types of tubes used at Virginia Beach?

A. The type most regularly used was of the single plate construction, Claimant's Ex. 177; the second type almost similar in construction employed a plate on each side of the filament, both plates being connected together; the third type having one large single plate with a very large filament.

R. D. Q. 381. I show you a collection of tubes which are exhibits in this case; can you pick out from them any tubes resembling the second and third types referred to in your last answer?

A. Exhibit No. 177 is on the order of the first type now [fol. 1100] tioned; Exhibit No. 178 is constructed along the same lines as the second type; while Exhibit No. 173 resembles more or less the third type.

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Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No, I can't say as I do.

Deposition Closed

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Deposition of Arthur A. Isbell, for Claimant, taken at New York, N. Y., on the 11th day of December, A. D., 1925

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First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence; whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry; and

whether, and in what degree, you are related to the claimant.

Answer: My name is Arthur A. Isbell; occupation, Assistant Traffic Manager Radio Corporation of America; my age is 51; residence, 85 Hicks Street, Brooklyn, New York; I have no interest either direct or indirect in this claim; I am not related in any way to the claimant.

Direct examination.

By Mr. Cosgrove:

Q. 382. What kind of traffic did you refer to in your last answer?

A. Wireless telegraph traffic.

Q. 383. How long have you been connected with the Radio Corporation of America, and in what capacity?

A. I have been connected with the Radio Corporation of America since November, 1919, at which time it took over the Marconi Wireless Telegraph Company of America. In the capacity first, as General Superintendent of the Pacific Division; later, Manager of the Pacific Division; at this date, Assistant Traffic Manager, New York Office Radio Corporation of America, and for the past six months.

Q. 384. By whom were you employed prior to November, 1919?

A. From the summer of 1912, until November, 1919, by the Marconi Wireless Telegraph Company of America at San Francisco, and in that vicinity.

Q. 385. What position did you hold with the Marconi Company?

A. Superintendent of Construction for the Pacific Division, from the summer of 1912, until August, 1915.

Q. 386. What business was the Marconi Company engaged in during the period you were employed by that company?

A. In the manufacture, sale and rental of wireless telegraph apparatus and in the wireless telegraph communication business.

Q. 387. Are you a wireless telegraph operator?

A. I am.

Q. 388. When you became connected with the Marconi Company in 1912, were they installing any wireless telegraph receiving apparatus on any vessels in and about the Port of San Francisco, under your direction?

A. They were.

Q. 389. What type of wireless telegraph receiving apparatus were they installing on these vessels at that time?

A. In the summer of 1912, when I became Superintendent of Construction, the Marconi Wireless Telegraph Company of America was installing Marconi tuners fitted with the Fleming valve detectors.

Q. 390. Look at the apparatus now shown you, and if you recognize it, state what it is.

(“Claimant’s Exhibit No. 193” shown witness.)

A. It is a Marconi wireless telegraph receiver fitted for the use of Fleming valve detectors.

Q. 391. In what, if any, respects does it resemble the Marconi valve tuners fitted with Fleming valves which were installed under your direction or supervision in 1912, on vessels in and about San Francisco?

A. To the best of my recollection it is an exact replica of those tuners installed in 1912.

Q. 392. I show you two devices, and if you recognize them, state what they are.

(Witness shown “Claimant’s Exhibits Nos. 174 and 175, Fleming Valves”.)

A. Fleming two-element valves.

Q. 393. How do they compare with the Fleming valves fitted into the Marconi valve tuners that you have referred to?

A. In appearance, I should say that the comparison is exact.

Q. 394. From what source did you obtain the Marconi valve tuners and Fleming valves which were installed on the vessels referred to?

A. From the New York headquarters of the Marconi Wireless Telegraph Company of America.

Q. 395. For about how long a period did you continue to receive and install these Marconi valve tuners fitted with Fleming valves?

A. From the summer of 1912 until I departed for Alaska, in May, 1914.

Q. 396. About how long a time were you in Alaska?

A. Fifteen months; I left Alaska in August, 1915.

Q. 397. What work were you connected with after you returned from Alaska, and where was that work being done?

A. After a vacation in San Francisco, I became Engineer in Charge of the Trans-Pacific Transmitting Station at Bolinas, California.

Q. 398. Were the Marconi valve tuners fitted with Fleming valves, which you have referred to, examined and tested by you or under your supervision, before or after they were installed on the vessels?

A. The Marconi tuners fitted with Fleming valves were almost always tested in the San Francisco shop for the purpose of determining whether both the receiver and the valve would function properly. These tests consisted of placing the valves in the tuners, connecting the same to a battery and connecting the tuner to an antenna and ground, making the usual adjustments of the controlling devices, so that wireless telegraph messages or signals could be received from the various commercial stations, merchant vessels and Naval Radio stations in the vicinity of San Francisco Bay. After checking and testing, the tuners fitted with the valves were installed on vessels and, if necessary, again tested on the ship or ships.

Q. 399. Did you ever personally receive any wireless telegraph messages with any of these Marconi valve tuners [fol. 1102] fitted with Fleming valves, and if so, what kind of messages and under what circumstances?

A. I did, many times; under the circumstances described in my previous answer.

Q. 400. Can you give us the names of some of the lines on which these Marconi valve tuners fitted with the Fleming valve were installed?

A. Matson Navigation Company and the Pacific Mail Steamship Company.

Q. 401. Do you recollect, and if so, will you state the names of any of the vessels on which these tuners fitted with Fleming valves were installed?

A. To the best of my recollection, Marconi tuners and valves were installed and successfully operated on the steamers Enterprise, Lurline, Hyades, San Juan, San Jose and Newport.

Q. 402. If you recollect, will you please state what service these vessels were engaged in and between what ports this service was carried on?

A. The first three named plied between San Francisco and ports in the Hawaiian Islands; the last three named

above between San Francisco and the Isthmus of Panama, and Central American ports between those two points.

Q. 403. Were the Marconi valve tuners fitted with the Fleming valves installed on these vessels supplied with a battery; if so, for what purpose was the battery used?

A. Batteries were supplied for the purpose of lighting the filaments of the Fleming valves in order to make the Fleming valves act as detectors of wireless telegraph signals.

Q. 404. Do you recollect what the voltage of these batteries was?

A. As I remember, these batteries were six volts.

Q. 405. When the Fleming valve fitted into these tuners was adjusted for the best signal on one wave length, was it necessary to change the adjustment in order to receive on other wave lengths, and if so, what adjustments were necessary?

A. Subsequent to adjusting the tuner to a different wave length, it was necessary to vary a little the potentiometer and rheostat of the circuit supplying current to the valve.

Q. 406. When the valve tuners fitted with a Fleming valve or valves were received and installed by you, were they fitted with any additional detector than the Fleming valve and, if so, what type of detector?

A. I think that in 1913, tuners were shipped to us together with adapters holding carborundum crystals that could be inserted in either one of the two sockets on the Marconi valve tuner.

Q. 407. For what purpose, if you know, was the additional carborundum crystal detector supplied for these valves tuners?

A. For the purpose of more economical maintenance and operation, and as an emergency detector. We frequently were confronted with the loss of valves, breakage of valves and improper or insufficient charging of the batteries supplying current to the valves.

Q. 408. Do you know for about how long a period these Marconi valve tuners fitted with the Fleming valve continued in use on the vessels you have referred to?

A. Vessels continued to be equipped with Marconi valve tuners up to the time I left for Alaska in May, 1914.

Q. 409. Have you any personal knowledge now as to just how long the valves were used on the vessels you have mentioned?

A. Do you mean those vessels I specifically named?
[fol. 1103] Q. 410. Yes.

A. No.

Q. 411. Up to the time when you left for Alaska do you recollect whether there were few or many of the adapters with the carborundum crystals received by you for use with the valve tuners?

A. I believe that every Marconi valve tuner at the time I left San Francisco for Alaska had been supplied with a carborundum adapter.

Q. 412. And this carborundum adapter was fitted into one of the sockets of the valve tuner?

A. Yes.

Q. 413. Were the Fleming valves which you received at San Francisco uniform in quality and performance?

A. No; the valves varied some in their detecting characteristics; in other words, in the degree in which they were able to detect wireless signals. However, when the valve was once adjusted, it was quite stable in its operation.

Q. 414. Did you ever make any direct comparison between the Fleming valves and the carborundum crystals supplied to you by your company under substantially the same conditions; and, if so, what were the results of the comparisons?

A. Many comparisons were made; probably every tuner fitted with the valve and a carborundum adapter had this comparative test in actual operation. It was a simple matter to actuate a double-throw switch while making a comparative test. Almost invariably it was found that the valve was the more sensitive detector and more stable in its operation.

Q. 415. Have you any personal knowledge of the use of the Fleming valve on any other vessels than those you have mentioned and, if so, please state what vessels these were and how you acquired such knowledge?

A. Vessels under the control of the English Marconi Company plying to San Francisco were fitted with Marconi valve tuners and, occasionally, these tuners were brought to the San Francisco shop for repairs. I have a very distinct recollection of an English oil tanker operated by the Standard Oil Company between San Francisco and the Orient, the Marconi valve tuner on which the San Francisco shop men sometimes repaired and tested.

Q. 416. What types of detectors were fitted in the valve tuners referred to in your last answer?

A. Fleming valve detectors.

Mr. Edwards: No cross-examination.

Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer. I do not.

Deposition Closed

Deposition of Gordon B. Rabbitts, for Claimant, taken at New York, N. Y., on the 11th day of December, A. D. 1925.

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence; [fol. 1104] whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry; and whether, and in what degree, you are related to the claimant.

Answer. My name is Gordon B. Rabbitts; occupation, Radio Operator; my age is 40; residence, Cosmopolitan Hotel, Chambers Street, New York, N. Y.; I have no interest, direct or indirect, in the claim which is the subject of inquiry, and I am not in any way related to the claimant herein.

Direct examination.

By Mr. Cosgrove:

Q. 1. By whom are you employed as a radio operator?

A. The Radio Corporation of America.

Q. 2. For how long have you been employed as a radio operator by that corporation?

A. Since they reorganized in 1919.

Q. 3. By what other companies have you been employed as a radio operator, and when?

A. About five years with the Canadian Marconi Company and the Marconi Company of America, from the spring of 1911 until 1919.

Q. 4. During about what period were you employed as radio operator by the Canadian Marconi Company?

A. From 1906 until the spring of 1911.

Q. 5. Did you ever act as a radio operator at the Glace Bay, Nova Scotia, Wireless Station of the Canadian Marconi Company?

A. Yes.

Q. 6. About when did you act as a radio operator at this Glace Bay Station?

A. I went down there shortly after they started commercial work in the fall of 1907, about November, I think it was.

Q. 7. Between what points was the commercial operation of the Glace Bay station carried on?

A. Between Clifden, Ireland, and Glace Bay.

Q. 8. For about how long a time did you continue to act as a wireless operator at the Glace Bay wireless station?

A. About a year and a half.

Q. 9. That is, a year and a half from November, 1907?

A. From November, 1907 to the spring of 1909.

Q. 10. Did you act as an operator at that station at any other time, and if so, during about what period?

A. In the spring of 1911 I went back there for about three weeks.

Q. 11. What type of detectors were used by you at the Glace Bay station when you first acted as an operator at that station?

A. The magnetic detector and a detector known as the Fleming valve.

Q. 12. What type of detectors did you use during the second period in which you acted as an operator at this Glace Bay station?

A. The detector known as the Fleming valve.

Q. 13. What did the detector known as the Fleming valve, and which you used at the Glace Bay wireless station, look like?

A. It looked like a small incandescent bulb (indicating), with two elements—a plate and filament.

Q. 14. Look at the two articles which I show you, and if you recognize them, state what they are and how they resemble anything used by you at Glace Bay. (Witness shown "Claimant's Exhibit 172" and "Claimant's Exhibit 175".)

A. We were using something like that at times (Witness [fol. 1105] refers to "Claimant's Exhibit No. 172"); this is the one we used continuously (witness referring to "Claimant's Exhibit No. 175").

Q. 15. Did you use a battery with the Fleming valves at Glace Bay, and if so, for what purpose did you use it?

A. Yes, to light the filaments.

Q. 16. About when did you first begin to use the Fleming valve in regular service at the Glace Bay station?

A. After about the first six months that I was there.

Q. 17. After your first six months at the Glace Bay station, to what extent was the Fleming valve thereafter used by you in receiving wireless messages at that station?

A. Continuously, except that at times we would switch over to the magnetic detector.

Q. 18. For what purpose did you switch over to the magnetic detector?

A. Just for comparison and try-outs.

Q. 19. What kind of messages did you receive during the period you used the Fleming valve at the Glace Bay station, and from where were those messages received?

A. General commercial messages and press, received from Clifden, Ireland.

Q. 20. About how many hours a day or night did you act as an operator at the Glace Bay station, using the Fleming valve to receive messages?

A. Four hours a day.

Q. 21. About how many other operators worked with you at Glace Bay in receiving messages with the Fleming valve, and how was the operators' time generally divided up?

A. The first part of my time there I had three operators: the time was split up, four hours each, four on land wire, four on radio. It was limited service, you know, for the first few months I was there, and we didn't have any night watch.

Q. 22. On an average about how many messages did you personally receive with the Fleming valve from Clifden, Ireland, during your four-hour watch?

A. I should say about thirty messages. Sometimes we were receiving press, and that would mean one continuous message.

Q. 23. About what time or times did it take to receive or copy these press dispatches or messages?

A. That would depend on the length of them, there were some longer than others, but if it was continuous copying, about eight hundred words an hour.

Q. 24. Did you ever take most of your four-hour watch to copy these press despatches?

A. Yes, often.

Q. 25. Can you roughly estimate the number of words received by you from Clifden, Ireland at Glace Bay, with the Fleming valve during an average watch of four hours, when press despatches were coming in?

A. Well, allowing for breaks in transmission, I would say at least twenty-five hundred words.

Q. 26. Will you also give us a rough estimate of the number of words you received at Glace Bay with the Fleming valve from Clifden, Ireland, during the period when you first acted as an operator at the Glace Bay station?

A. I should say over two hundred and fifty thousand.

Q. 27. In your experience with the Fleming valve in receiving wireless messages from Clifden, Ireland, and also from your experience with the magnetic detector in that [fol. 1106] work, how did the two detectors compare in usefulness?

A. The Fleming valve was a great improvement; at times when we couldn't hear at all on the magnetic, it came in good on the valve.

Q. 28. When you left the Glace Bay wireless station, after your first service there, was the Fleming valve still in use?

A. Yes, it was.

Q. 29. For about how long a time did you use the Fleming valve at the Glace Bay station on your return to service as operator there in the spring of 1911?

A. We used it continuously,—about three weeks.

Q. 30. For what purpose was the valve used during these three weeks?

A. For the receiving of the regular messages, press and services.

Q. 31. From where were these messages received?

A. Clifden, Ireland.

Q. 32. How did the wireless traffic between Glace Bay and Clifden, Ireland, compare at the time of your second service at Glace Bay, in 1911, with the wireless traffic at the time of your first service at Glace Bay?

A. There was quite an increase; we were handling about double the business.

Q. 33. About how many radio operators were handling the traffic at Glace Bay at the time of your second service there?

A. Ten or twelve operators; some of them were on clerical work and things like that.

Q. 34. Do you recollect about how many were engaged in actually receiving from Clifden, Ireland?

A. There were six during the twenty-four hours.

Q. 35. Did you use the magnetic detector during your second service at Glace Bay?

A. No, not for commercial purposes.

Q. 36. When you left the Glace Bay station, after the period of your second service there, was the Fleming valve still in use in receiving messages from Clifden, Ireland?

A. Yes.

Q. 37. Did you ever make use of the Fleming valve as a wireless detector aboard any ships?

A. Yes, on the S. S. Philadelphia, of the American Line.

Q. 38. About when did you first use the Fleming valve as a detector aboard the S. S. Philadelphia?

A. When I joined her in August, 1912.

Q. 39. For how long a period did you continue to use the Fleming valve as a detector on the S. S. Philadelphia?

A. All the while I was on there, from August, 1912, to the spring of 1913, somewhere about May, I think.

Q. 40. Do you recollect the name of the operator whom you relieved aboard the S. S. Philadelphia when you first joined that ship?

A. Yes; Mr. Charles J. Weaver.

Q. 41. During the period you acted as an operator and used the Fleming valve on the S. S. Philadelphia, in what service was that ship engaged?

A. In the passenger service between New York and Southampton, England, and Cherbourg, France, in the Trans-Atlantic passenger service.

Q. 42. What was the character of the messages you received with the Fleming valve, while you acted as an operator [fol. 1107] aboard the Philadelphia?

A. Regular commercial messages, ship's business and press.

Q. 43. Did you ever receive any long-distance messages with the Fleming valve while you acted as an operator

aboard the S. S. Philadelphia, and if so, what was the character of the messages and from where were they received?

A. Yes, from Cape Cod and Poldhu, they were press messages.

Q. 44. And about what was the distances over which these messages were received by you?

A. We held both stations about half-way across.

Q. 45. Did you ever receive with the Fleming valve while aboard the Philadelphia, from any other vessel, at a distance of over a thousand or fifteen hundred miles, and if so, when and what vessels?

A. Yes, we exchanged messages with one of the Kaiser boats. I forget just which one it was—a distance of fifteen or eighteen hundred miles we were east of Cape Race at the time.

Q. 46. Did you ever receive any distress signals with the Fleming valve while you were an operator aboard the Philadelphia, and if so, when and under what circumstances?

A. Yes, during the winter I was on the Philadelphia. We received distress signals from an English cargo ship. I think she was called the Wanderer. We handled some of the correspondence connected with the distress call.

Q. 47. While you acted as an operator on the Philadelphia, was she equipped with any other type of wireless detectors than the Fleming valve?

A. Yes, we had the magnetic detector as a standby.

Q. 48. What do you mean by "stand-by"?

A. I mean "stand-by" or "emergency".

Q. 49. Which detector, the magnetic or the Fleming valve, was normally used on the Philadelphia?

A. The Fleming valve.

Q. 50. Please look at the apparatus now shown you and if you recognize it, state what it is, and if you ever used it. (Witness shown "Claimant's Exhibit No. 193, Marconi Tuner or Receiver".)

A. This is the old Marconi tuner which was used with the Fleming valve; it looks very much like it.

Q. 51. Do you mean that this apparatus looks like the tuner used with the Fleming valve aboard the Philadelphia?

A. Yes, it looks like it.

Q. 52. When you left the Philadelphia, was the Fleming valve still in use aboard that ship?

A. Yes.

Q. 53. After leaving the Philadelphia, at what wireless station did you next serve as a wireless operator?

A. At Sagaponack, Long Island, New York.

Q. 54. By whom was this Sagaponack wireless station operated?

A. The Marconi Wireless Telegraph Company of America.

Q. 55. How soon after you left the S. S. Philadelphia did you begin work as an operator at the Sagaponack station?

A. Immediately after.

Q. 56. During what period of time did you continue to act [fol. 1108] as an operator at the Sagaponack station?

A. From the spring of 1913, to the fall of 1915.

Q. 57. How do you fix the date as the fall of 1915, when your services as an operator ended at the Sagaponack station?

A. Because it was the second year of the War and I dismantled the station, and it was cold weather.

Q. 58. Do you know why the Sagaponack station was dismantled at that time?

A. Through lack of business owing to war conditions.

Q. 59. During the period you acted as a wireless operator at the Sagaponack station from the spring of 1913, to the fall of 1915, what type of receiver and detector were used by you at that station?

A. The receiver was something like this, with the Fleming valve (witness refers to "Claimant's Exhibit No. 193").

Q. 60. Was this receiver fitted with the Fleming valve in use at the time the Sagaponack station was dismantled?

A. Yes.

Q. 61. What was the character of the messages you received with the Fleming valve at the Sagaponack station?

A. General commercial messages and press from ships at sea.

Q. 62. How important a wireless station was the Sagaponack station?

A. It was considered very important, second to the Sea Gate station.

Q. 63. On what part of Long Island was the Sagaponack station located?

A. On the Eastern end of it, about thirty-five miles West of Montauk Point.

Q. 64. In your experience with the Fleming valve how satisfactory was it as a wireless detector.

A. It seemed to work very satisfactorily.

Q. 65. In your experience with the Fleming valve did you find all of the Fleming valves uniform in sensitiveness; if not, how did they differ?

A. No; some were more sensitive than others.

Q. 66. In your experience with the Fleming valve, what adjustments did you have to make in the valve circuit in changing from one wave length to another?

A. No adjustment of the valve itself; sometimes varied the filament battery.

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Mr. Edwards: No cross-examination.

Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

Deposition closed.

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Deposition of Cyril D. Reinhard, for Claimant, taken at New York, N. Y., on the 29th day of December, A. D. 1925

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First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence, whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and [fol. 1109] whether, and in what degree, you are related to the claimant.

Answer: My name is Cyril D. Reinhard, my age is 45; residence, Borough of Manhattan, New York City; I have no interest whatever in the claim; I am not related in any way to the claimant.

Direct examination.

By Mr. Cosgrove:

Q. 1. Are you a wireless telegraph operator?

A. I am.

Q. 2. Do you hold any license as such operator, and if so, from whom, and what grade?

A. I hold a First Class First Grade license issued by the Department of Commerce of the United States.

Q. 3. For about how long have you held such license?

A. Ever since the United States has issued such licenses.

Q. 4. Do you know when they began to issue such licenses?

A. 1910 or 1911.

Q. 5. Please state in a general way what practical experience you have in wireless work.

A. My first knowledge of wireless was gained in the United States Navy in 1903. After my discharge from the Navy I was employed by various wireless companies as operator, engineer, sales manager and in practically all capacities except that of financing in connection with wireless work.

Q. 6. When did you enter and leave the Navy?

A. 1903 to 1907.

Q. 7. Were you ever employed by the United Fruit Company, and if so, when and where and in what capacities?

A. Yes, from I think in March, 1911, until April, 1915. First I was senior operator on the Steamship Limon, running between Boston and Puerto Limon, Costa Rica. I was afterwards transferred to the S. S. Metapan of the same company, running between New York and Central and South America, on which ship I served as senior operator until transferred to Santa Marta, the Republic of Columbia, to be the United Fruit Company's representative during the erection of the 50-kilowatt station at that point. After the station had been completed by the Marconi Wireless Telegraph Company of America, I was the operator in charge of this station for approximately three years.

Q. 8. Were you ever employed either by the claimant herein or the Radio Corporation of America?

A. I was employed by the Marconi Wireless Telegraph Company of America for one voyage only on the S. S. Segurana from New York to Buenos Ayres and return. I have never been employed by the Radio Corporation of America.

Q. 9. What if any experience have you had in the use of a wireless device known as the Fleming Valve?

A. I used the Fleming valve for handling commercial traffic while I was stationed at the Santa Marta station of the United Fruit Company.

Q. 10. Will you describe generally the Fleming valve or valves used by you at the Santa Marta wireless station?

A. We had many types of Fleming valves supplied us, but in general they were usually cylindrical glass tubes about $\frac{3}{4}$ of an inch in diameter and 4 inches long, provided with the necessary base for making electrical connections to the filament.

Q. 11. What elements were inside of the cylindrical glass tube?

A. A filament or heating device and another element called the plate.

Q. 12. I show you half a dozen devices and if you recognize any of them, please state what they are.

[fol. 1110] A. These objects are Fleming valves. I note that the filaments are broken in some of them; and they are quite similar in appearance to those supplied me at Santa Marta, especially these three which are not marked. Those tubes which we had were more like these than the small fat ones.

Mr. Cosgrove: (It is noted that the witness was shown Claimant's Exhibits Nos. 173, 175, and 176 Fleming Valves, and three unmarked devices, which the witness has identified as Fleming Valves.)

The latter devices are offered in evidence and marked respectively "Claimant's Exhibits Nos. 195, 196 and 197, Fleming Valves.

Q. 13. During what period or about what time did you serve as wireless operator at the Santa Marta station of the United Fruit Company?

A. From 1912 to 1915.

Q. 14. Do you recollect the month of 1912 when you first began to serve as an operator and the month in 1915 when you ceased to serve as such operator at that station?

A. To the best of my recollection, it was in March, 1912, until April, 1915.

Q. 15. Were you the only wireless telegraph operator serving at Santa Marta station during the period mentioned in your last two answers?

A. For the first two and a half years, yes; until I became ill and was sent to the hospital, which necessitated the closing of the station until a relief operator was sent to Santa Marta, who afterwards acted as my assistant.

Q. 16. Do you know from whom the Fleming valves which you used at the Santa Marta station were received?

A. Yes, from the Marconi Wireless Telegraph Company of America.

Q. 17. How do you know this?

A. Because it was necessary for me to sign the receipts or shipping vouchers which were afterwards returned to the shippers. I unpacked the cases.

Q. 18. With what type of receivers did you use the Fleming valve while you served as an operator at the Santa Marta station?

A. With those receivers which we knew as the Marconi Ship-Type Valve Receiver, and the Marconi Balanced Crystal-Valve Receiver.

Q. 19. Please look at the apparatus now shown you and state what it is, if you know. (Witness shown Claimant's Exhibit No. 193.)

A. This is a Marconi Ship-Type Valve Receiver, very similar to the one which I used at Santa Marta. It might be the same one, it looks just like it.

Q. 20. Were you supplied with any detector other than the Fleming valve to use with this Marconi ship valve receiver while you were at Santa Marta?

A. No.

Q. 21. Will you please describe to the best of your recollection the Marconi balanced crystal valve receiver referred to in your answer to Q. 18?

A. We had two of these receivers which were identical, and as I remember they were flat structures about 18 inches by 11 and 2 or 2½ inches high with valve sockets and crystal holders mounted on the surface together with rheostats for controlling the filament voltage.

Q. 22. Were these balanced valve and crystal receivers long wave receivers?

A. They were.

Q. 23. Will you please state how the Fleming valves and [fol. 1111] crystals functioned in this balanced receiver—that is, did the valves and crystals function independently or in combination?

A. In combination.

Q. 24. That is both the crystals and valves must be operative in order to receive signals?

A. Yes, both.

Q. 25. Just what do you mean by calling this receiver a balanced receiver?

A. A receiver in which the static is minimized or balanced out so that the signals can be received.

Q. 26. Can you describe or illustrate the details of the circuits of these balanced receivers?

A. No, I cannot, because it is more than ten years since I have seen or used them.

Q. 27. Do you know who manufactured these balanced receivers?

A. Yes, they were made by the Chelmsford Works of the Marconi Company in England.

Q. 28. For what kind of work were the Marconi ship valve receiver fitted with the Fleming valve, and the balanced receiver fitted with those valves and crystal detectors used by you at the Santa Marta station?

A. The Marconi ship type receiver used with the Fleming valve for detector was employed for communication with the various vessels of the United Fruit Company and for communication with the Naval Station at Colon, the Republic of Panama. The balanced receivers were used for point to point communication—that is, between Santa Marta and Port Limon, Costa Rica, Swan Island, Honduras, Cape San Antonio, Cuba, and New Orleans, Louisiana.

Q. 29. While at Santa Marta did you regularly receive wireless messages from New Orleans, and other points, with the Marconi ship valve tuner fitted with the Fleming valve?

A. The Marconi ship type valve receiver was used at Santa Marta as a standby, and it was usual at scheduled time with one of the more distant stations to shift over to the balanced receiver, as these had been preadjusted for the particular wave length of the distant station. It was, however, possible and practicable to communicate with any of our stations using only the ship type receiver.

Q. 30. Was it the practice to pick up the distant station with the ship valve tuner and then shift to the balanced receiver?

A. No, because we adhered very rigidly to exact scheduled time and unless the traffic with one station was particularly heavy and we overran the schedule time, we usually shifted to the balanced receiver when one of the distant stations was due to communicate with us; if we did run over of course we could hear the other stations calling us on the ship type receiver.

Q. 31. While at Santa Marta, using the ship type of receiver fitted with the Fleming valve or valves, did you ever actually receive messages from New Orleans?

A. Yes.

Q. 32. Will you please state the approximate distances from Santa Marta to New Orleans, to Swan Island, to Port Limon, and to Colon?

A. Approximately the air line distance from Santa Marta to New Orleans is 1,470 miles. To Swan Island 685. To Port Limon 547, and to Colon 325.

Q. 33. How were the static conditions at Santa Marta during the time you served as an operator there?

A. The static was worse in Santa Marta than I have ever experienced in 20 years of service as a radio operator.

Q. 34. How successful or efficient were the Fleming valves [fol. 1112] used by you at Santa Marta as detectors under static conditions?

A. Efficient enough to handle the United Fruit Company's important traffic, except at such times as the static was so strong that signals could not be heard with any type of detector.

Q. 35. What kind of crystals were furnished you while at Santa Marta for use in the balanced receiver?

A. Carborundum.

Q. 36. While at Santa Marta did you ever make any direct comparison between the Fleming Valve and any crystal detector, and if so, what type of crystal detector, and what is your recollection of the comparison made?

A. Yes. I have made direct comparisons between the Fleming valve and the carborundum detector and a silicon detector; the sensitivity of the three types of detectors was about the same, but the reliability of the valve was greatly superior to that of either of the crystal detectors.

Q. 37. Will you please state what you mean by "reliability" as stated in your last answer?

A. That quality in a detector of wireless signals which enables the receiving operator to hear and record accurately the greatest number of signals from the transmitting stations.

Q. 38. In your experience, which quality have you found more desirable in a wireless detector—sensitiveness or reliability?

A. Reliability.

Q. 39. Is reliability essential in order to handle commercial wireless traffic, and if so, why?

A. It is absolutely essential and in order to explain why, or rather to point out so that those not familiar with telegraphing can understand more readily, take for instance the telegraphic correspondence of the United Fruit Company, which is almost invariably in code. By code I mean artificial words. The United Fruit Company's code is made up of unpronounceable groups of ten letters. If the receiving operator has not a detector which is reliable and should miss one dot in a letter of the Morse code, for instance changing a B to A D or an H to an S, it would change the entire meaning in translation of the received word.

Q. 40. In what respects or why were the crystal detectors more unreliable than the Fleming valve?

A. Because in severe static the crystal detector is more easily "knocked out" of adjustment or paralyzed, and does not recover as quickly as the valve type detector.

Q. 41. In your experience with the Fleming valves did you find that they were all of the same order of sensitiveness, and if not, generally speaking, how did they differ in this respect?

A. The Fleming valves supplied to me at Santa Marta varied greatly in their characteristics, principally in their sensitivity and length of useful life.

Q. 42. In using the Fleming valves at Santa Marta was any battery employed and if so, for what purpose?

A. Yes, for heating the filament of the valve.

Q. 43. Did you ever receive any distress calls while at Santa Marta while using the Fleming valve as a detector? If so, please state about when and under what circumstances?

A. Yes; while listening in for one of the regular schedules with one of my corresponding stations, I received distress signals from W. K. Vanderbilt's steam yacht "The Warrior" which had gone aground between Puerto Colombia and Santa Marta. The exact date of this I am unable to recall, but it can easily be ascertained because it is a matter of record. It was probably in 1913.

[fol. 1113] Q. 44. While at Santa Marta were you supplied with, and did you use a type of detector known as the "magnetic detector", and if so, to what extent was the magnetic detector used by you?

A. Yes, I was supplied with two magnetic detectors, one made in England at Chelmsford, and the other made in the United States. These magnetic detectors were used infrequently, because of the superiority in sensitivity of the valve detectors.

Q. 45. Did you continue to use the receivers fitted with the Fleming valves in commercial work at Santa Marta up to the time that you left that station?

A. Yes.

Q. 46. Were you supplied with any other receiver than the ones fitted with the Fleming valve while you were at Santa Marta, and if so, what was the type of receiver and what detector was used with it?

A. As I said before, we had two magnetic detectors which could be used with the tuning devices supplied in the form of the ship type receiver or the balanced crystal receiver, and about January, 1915, I was supplied with a new type of receiver made at Aldene, which employed a three-element valve.

Q. 47. What use was made of this type of receiver fitted with the three-element valve at Santa Marta before you left there?

A. It was used experimentally, because having successfully handled commercial traffic on the receivers and detectors originally supplied, we felt more safe in depending upon them and the new receiver and detector were tried out on communications less important than our regular schedules.

Q. 48. What vessels did you serve on while in the United States Navy, in what capacities did you serve on these vessels, and state, if you recollect, about the time of each service on the vessels respectively?

A. I served aboard Diamond Shoals Light Vessels, No. 81 and 82, as a radio operator after my graduation from the Electrical School at the Brooklyn Navy Yard for about eight months. This was 1903-4, that is the fall of 1903-4. I was then transferred to the U. S. S. Iowa, and served as a wireless operator and electrician. This was about 1905. From the U. S. S. Iowa I was transferred to the U. S. S. New Jersey, where I served in the same capacity until my four years in the Navy had expired.

Q. 49. Where were the two Lightships you have referred to located at the time you served as an operator aboard those ships?

A. Off Cape Hatteras, Virginia.

Q. 50. How important were these lightships in coastwise traffic?

A. Second in importance to Nantucket Shoal Light vessels, as Cape Hatteras or Diamond Shoals is the point at which North and South bound steamers change their courses.

Q. 51. Will you please state your recollection of the type of transmitter and receiver installed on the Diamond Shoals Lightships at the time you served as an operator on those ships?

A. The wireless apparatus on the Diamond Shoals Lightships was manufactured by the National Electric Signaling Company and known as the Fessenden System. The power for the transmitter was supplied from a bank of storage batteries to a one-kilowatt rotary converter. The transmitting circuit was a tuned coupled circuit in which the spark gap was partially enclosed and cooled by a blast of air. The receiving circuit was the standard Fessenden circuit employing tuned coupled circuits and using an electrolytic detector.

[fol. 1114] Q. 52. What do you mean by "tuned coupled circuits" in your last answer?

A. A circuit in which the primary and secondary are in resonance, or nearly so.

Q. 53. Referring to the blast of air on the spark gap, referred to in your answer to Q. 51, from what source was this air supplied?

A. From a small blower actuated by a motor especially installed for that purpose.

Q. 54. Please describe the transmitting set installed on the Iowa when you served as an operator on that ship?

A. A mercury turbine interrupter supplying interrupted direct current to a large Ruhmkorff coil which charged the Leyden jars, the Leyden jars discharging through an inductance which we called the auto-transformer, and a fixed open spark gap to the antenna circuit.

Q. 55. What was the character of the circuits of the Iowa transmitter?

A. Both the transmitter and receiver were tuned coupled circuits.

Q. 56. Was the spark gap of the transmitter of the Iowa ventilated in any way, and if so, in what way?

A. Yes, by a small electric fan, which was mounted underneath the jar rack.

Q. 57. Will you generally describe the receiver you operated aboard the Iowa?

A. The receiver used on the Iowa when I was first assigned to that ship was a coherer set made by the Slaby-Arco Company of Germany. The coherer was shunted across the auto-transformer receiving inductance and actuated by a battery, also employing a Morse printer for recording of received signals.

Q. 58. While you acted as an operator aboard the Iowa, what was the longest distance you were able to receive using the coherer as a detector?

A. 90 miles.

Q. 59. How do you happen to remember this?

A. Because it was out of the ordinary to communicate over such a distance with a coherer and all the operators in the fleet commented upon this performance.

Q. 60. Did you use any other type of transmitter while you acted as an operator aboard the Iowa than that mentioned in your answer to Q. 54, and if so, what type of transmitter?

A. Yes, the mercury turbine interrupter was replaced by an alternating current motor generator, which supplied alternating current to the Ruhmkorff coil instead of interrupted direct current.

Q. 61. If you recollect, will you state what the character of the circuits of this transmitter were?

A. It was a tuned coupled circuit.

Q. 62. Will you please state what type of transmitter and receiver were installed aboard the Battleship New Jersey while you served as an operator aboard that ship?

A. It was a Standard Shoemaker set.

Q. 63. What was the character of the spark gap of this transmitter and the character of its circuits, and those of the receiver?

A. Both the transmitter and receiver had tuned coupled circuits. The transmitter was supplied with alternating current from the motor generator, using a transformer which charged the Leyden jars or condensers discharging across a fixed spark gap through an inductance coupled to the antenna circuit. The receiver circuit was a tuned coupled circuit using an electrolytic detector with glass enclosed detector points.

Q. 64. Were either one or both of the coupled tuned circuits of the transmitters or receivers operated by you while you were in the Navy provided with any means for adjusting or varying the capacity or inductance of the circuits, [fol. 1115] and if so, which circuit could be varied and how?

A. In both the Slaby-Arco and Shoemaker transmitting circuits, the inductance could be varied by means of a sliding contact so that more or less inductance would be inserted in the primary and secondary circuits. The capacity could also be varied by cutting out of circuit some of the Leyden jars. In the receiving circuits there was no means provided for changing the capacity and tuning was done by changing the inductance by means of sliders which permitted the operator to increase or decrease the number of turns of inductance in the receiving circuit.

Q. 65. Did you have any wave meters on board the vessel on which you served as an operator while in the Navy?

A. No.

Q. 66. While you were operating coupled tuned sets in the Navy how did you determine that the coupled circuits were in tune—I am referring to the circuits of the transmitter?

A. By the fatness and quality of the spark in the anchor gap.

Q. 67. What do you mean by the "anchor gap"?

A. The small spark gap in the antenna which cut off the transmitter from the receiver while receiving on the antenna.

Q. 68. Referring to the sets installed on the Diamond Shoal Lightships, what means, if any, were provided for adjusting or varying the capacity and inductance of the coupled tuned circuits?

A. The transmitting condensers were not variable and tuning was accomplished by changing the number of turns of wire in the transmitting inductance. The receiving set was tuned in the same way, that is, by varying the number of turns of wires in the tuning inductance. There were no variable receiving condensers employed in these sets.

Cross-examination.

By Mr. Edwards:

X Q. 69. After you left the Santa Mara station in 1915, what was your occupation?

A. I did not do anything for almost a year. I had not had a vacation all the time I had been in Santa Mara, and I had saved my money and took life easy in New York.

X Q. 70. What was your next occupation?

A. In the fall of 1916 I made a trip as operator on the SS. Seguranca.

X Q. 71. What line?

A. It was independently owned.

X Q. 72. What kind of receiver did you have on that ship?

A. An old United Wireless receiver with a carborundum detector.

X Q. 73. What kind of transmitter did that have?

A. A United Wireless transmitter.

X Q. 74. Did it have a loading coil in the antenna?

A. Not as I recall, no.

X Q. 75. How was its wave length adjusted?

A. At that time ships were not required to work on any predetermined wave length, and all ships and stations used that wave length by which the greatest radiation was obtained. We made no adjustment for any particular wave length.

X Q. 76. What was the wave length of the United Wireless transmitter?

A. I don't know.

X Q. 77. What was the wave length of the transmitter at the Diamond Shoals Lightship?

A. I don't know.

X Q. 78. What was the wave length on the transmitter of the Iowa?

A. I don't know.

[fol. 1116] X Q. 79. Did the transmitter at the Diamond Shoals Lightship, or that on the Iowa, have a loading coil?

A. Not as I recall, no.

X Q. 80. Was any adjustment of the wave length of the transmitter ever made at either of these stations to your knowledge?

A. Yes, on the Lightship.

X Q. 81. How was this done?

A. By a Naval expert radio aide, or as I remember he was called an electrical aide.

X Q. 82. What did he do to change the wave length?

A. Adjusted the transmitter inductance.

X Q. 83. By transmitter inductance do you mean the inductance in the antenna circuit?

A. By the transmitting inductance I mean the primary and secondary of the transmitter circuit.

X Q. 84. Can you not explain in detail just what changes the Naval Expert made in order to adjust the wave length?

A. It would be perhaps more accurate to say that the wave length was changed, rather than "adjusted" to any particular length. This was done by electrically varying the number of turns of wire in the primary and secondary circuits of the transmitter.

X Q. 85. Did he explain to you why he made the change?

A. No.

X Q. 86. Did you know the reason for the change?

A. No.

X Q. 87. Do you know that the changes that he made changed the wave length?

A. Yes.

X Q. 88. How do you know this?

A. Because I had read Fleming's book and knew that changing the length of wire or amount of wire in the primary or secondary circuit would change the wave length.

X Q. 89. Can you explain why this is so?

A. No, I cannot explain myself, I simply accept the usual explanation as given by radio and wireless authorities.

X Q. 89. Did the Naval Expert change the inductance in the primary or the secondary circuit, or in both circuits?

A. In both.

X Q. 90. Did not changing the adjustment in both circuits merely change the degree of coupling without necessarily changing the wave length?

A. I don't know.

X Q. 91. Are you now engaged in wireless telegraphy or telephony?

A. No at this exact time.

X Q. 92. What is your present occupation?

A. I am on a vacation.

X Q. 93. How long have you been on a vacation?

A. Since about November 1.

X Q. 94. What was your occupation before that time?

A. Sales Manager for Otto R. Gischow, Inc.

X Q. 95. How long has it been since you ceased work as an operator in the wireless telegraph field?

A. April, 1925.

X Q. 96. After 1915 did you have any occasion to use any of the two-element Fleming valves in your work as an operator?

A. No.

X Q. 97. Did you see any of them in use in commercial stations.

A. No.

X Q. 98. Were you occupied more or less continuously as a wireless operator between 1915 and 1925?

A. Yes.

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Redirect examination.

By Mr. Cosgrove:

R. D. Q. 99. Were you ever in the employ of Emil J. Simon, if so, during what period and in what capacities?

[fol. 1117] A. Yes, I was Chief Engineer for Emil J. Simon from 1917 to 1920, and during part of 1920 was General Superintendent of the Radio Communication Company, which was owned by Emil J. Simon, and in 1921 was General Traffic Manager for the Intercity Radio Company, which was also controlled by Emil J. Simon.

R. D. Q. 100. What business was Emil J. Simon engaged in in 1917 and 1918?

A. The manufacture of radio telegraph transmitting and receiving apparatus for the United States Navy, Army, and the French Government.

R. D. Q. 101. In general what was the character of these transmitting and receiving sets?

A. The transmitters were the quenched spark type using a coupled tuned circuit. The receiving sets employed tube detectors and coupled tuned circuits.

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Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

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Deposition of Wilson Aull, Jr., for Claimant, taken at New York, N. Y., on the 21st day of May, A. D. 1926

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence, whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and whether, and in what degree, you are related to the claimant.

Answer: My name is Wilson Aull, Jr.; age, 30; residence, 88 Goodrich Street, Astoria, Long Island, New York; occupation, Radio Engineer; I have no interest, directly, or indirectly, and I am not related in any way to the claimant.

Direct examination.

By Mr. Vaill:

Q. 1. Where are you located in the practice of radio engineering?

A. I have an office at 41 Park Row, New York City. I am engaged in experimental and research work.

Q. 2. What practical experience have you had in qualifying you to conduct tests on radio receiving apparatus of the coherer and crystal detector types?

A. I entered the radio field in 1908 as a radio amateur; at this time I was attending school. I read what radio periodicals I could find, subscribed to some and read what books and radio literature I could find in the Public Library. I also supplemented this reading with the construction of practical wireless transmitters, and receivers and experiments regarding them, and assisted my friends and others who became interested in the subject. I continued in this way until about 1913, when I organized a radio company at East St. Louis, Illinois, specializing in radio receiving and transmitting equipment. I also obtained a first grade [fol. 1118-1119] operator's license with the grade of "Excellent" at about this period. Later I studied at Columbia University and from tutors in this country and abroad, specializing in mathematics and engineering subjects.

In the spring of 1917, while at Columbia University, I also served as an instructor in a school in which Merchant Marine Officers were inducted into the United States Naval Reserve.

In June, 1917, I entered the Navy and continued in the Navy until March, 1919. In the Navy I was assigned to radio duties at various stations and Naval bases in this country and abroad, and was commissioned an Officer in the Naval Reserve.

In 1919 I entered the employ of the International Radio Telegraph Company as a radio engineer, in which capacity I served until the summer of 1920, when the International Company was acquired by the Westinghouse Electric and Manufacturing Company. I continued with them as a Radio Engineer until the Fall of 1921, at which time the International Radio Telegraph Company was merged with the Radio Corporation of America.

Since 1921, I have been doing radio engineering and consulting work, up to the present time.

I have operated and constructed several forms of coherers, my interest in the coherer being chiefly in connection with its use as a scientific instrument. I have also come across several types in various laboratories, and have used them also. The types I have used include the ordinary iron filings coherer, the nickel and silver coherer and later forms of the so-called auto coherer, containing carbon granules and similar types of microphone coherers, such as the sharpened arc carbon type, with the needle laid across them. I have also used and operated many forms of crystal detectors, and other forms of receivers in general use.

[fols. 1120-1121] Deposition of FRED H. KROGER, for Claimant, taken at New York, N. Y., on the 4th day of June, A. D. 1926.

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First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence, whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and whether, and in what degree, you are related to the claimant.

Answer: My name is Fred Hutton Kroger; age, over 30; residence, Hempstead, Long Island, New York; occupation, Division Radio Engineer; I have no interest, directly or indirectly, and I am not related in any way to the claimant.

Direct examination.

By Mr. Vaill:

Q. 1. Is your occupation as Division Radio Engineer in connection with the Radio Corporation of America?

A. Yes.

Q. 2. From about when have you been connected with practical operation of radio transmitting and receiving apparatus?

A. From 1906.

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[fol. 1122] Deposition of ERNEST R. CRAM, for Claimant, taken at New York, N. Y., on the 7th day of October, A. D. 1926.

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First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence; whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry; and whether, and in what degree, you are related to the claimant.

Answer: My name is Ernest R. Cram; of legal age; temporary residence, Clarendon Hotel, Brooklyn, New York; occupation, Radio Engineer, with the Radio Corporation of America; I have no interest direct or indirect, in this claim, and I am not related in any way to the claimant herein.

[fol. 1123] Direct examination.

By Mr. Vaill:

Q. 1. How long have you been connected with the Radio Corporation of America, and in what capacity?

A. Since the Fall of 1924, as Radio Engineer.

Q. 2. What was your occupation previous to being connected with the Radio Corporation of America?

A. Radio Engineer in the Signal Corps U. S. Army.

Q. 3. Were you familiar with the receivers used by the Signal Corps in radio pack sets, referred to by Mr. Loftin on pages 1116 and 1117 of the printed record, and else-

where in the record, and if so, during what period does your knowledge of these sets cover?

A. Yes, beginning in 1911 and continuing until some time after the United States entered the World War.

Q. 4. What type of receivers constituting these pack sets were you familiar with during that period?

A. The early type as made by the Foote-Pierson Company and the later types A, B, C and D.

Q. 5. Will you please state what circumstances allowed you to become familiar with these sets?

A. The Foote-Pierson type was the one in use in the Signal Corps when I entered its service and I designed either wholly, or in part, the types A, B, C and D.

It was a part of my duty to visit the plants of the manufacturers who were making these various types of sets; on these occasions I tested the sets, either in parts, or as a whole, and almost always tested the sets before final acceptance by the Signal Corps.

Q. 6. Please state the names of the manufacturers who manufactured the types A, B, C and D sets, as referred to in your last answer.

A. The National Electrical Supply Company, Washington, D. C.; the Electrical Industries Manufacturing Company and the Foote-Pierson Company, both of New York City; the American Radio and Research Corporation, Medford, Mass.; the General Electric Company, Schenectady, N. Y., and others that I do not now recall.

Q. 7. Referring to the receiving sets of the Atlantic Communication Company, mentioned on printed pages 1116 and 1117, and elsewhere in the record, what types of sets were furnished to the Signal Corps by that Company?

A. The same types of sets as had previously been furnished by the Telefunken Company, except that the Atlantic Company did not furnish any radio wagon sets.

Q. 8. Please designate the types of sets supplied by the Atlantic Communication Company?

A. These were station and ship sets, types E-4, E-5 and GAHU.

Q. 9. Referring now to the Telefunken Company's receiving sets mentioned on printed page 1119 and elsewhere, what types did they furnish to the Signal Corps?

A. Type GEK-2 in the radio wagon sets and also the station and ship sets, types E-4, E-5 and GAHU.

Q. 10. What were the general circuit arrangements of these Telefunken and Atlantic Communication Companies' receiving sets?

A. The circuits of the Telefunken and Atlantic Companies' sets were the same, in general, as the types A and B which, as I stated in an earlier answer, I had designed.

There were two tuned circuits inductively coupled by [fol. 1124] an oscillation transformer with variable coupling and provided with crystal detectors and high impedance or high resistance telephones. The primary circuit consisted of the antenna, an adjustable or variable part of the inductance or primary coil of the oscillation transformer, a variable condenser put either in shunt or in series with this inductance by means of a switch, or else a series condenser which could be put into circuit or cut out of circuit by a switch, and the ground or counterpoise. The coupling between the circuits was varied by moving the secondary coil of the oscillation transformer toward, or away from, the primary coil. The secondary circuit consisted of the secondary coil of the oscillation transformer, the crystal detector and a telephone or stopping condenser, all in series, and having the high resistance telephones in shunt to the condenser. The secondary coil was adjustable in steps, either by a variable switch arm moving over a set of contacts connected to different points on the coil, or else by a plug which could be inserted in any desired one of several sockets that likewise were connected to several points on the secondary coil.

Q. 11. How were these sets mentioned in your last answer adjusted or tuned to the required wave length?

A. The primary circuit was tuned either by changes of inductance by small steps, or by the variable condenser, or by both changes of inductance and changes of variable condenser. The secondary circuit was tuned by steps of inductance in the secondary coil, which coil had both inductance and distributed capacity. The tuning in the secondary by means of steps of inductance and distributed capacity was broader than when a variable condenser was used in the secondary circuit so that, at any one secondary contact, the circuit was really tuned not to a single wave length, but a certain range or band of wave lengths. Thus the first contact or socket would be tuned to and give a substantially equal response to wave lengths say between

300 and 450 meters and at the second contact between 450 meters and 700 meters, and at the third contact from 700 meters to 1200 meters, and so forth.

Q. 12. Will you please explain how the kinds of coils used in the secondary circuit permitted tuning through inductance and distributed capacity, referring to the Signal Corps sets types A and B, mentioned by you in your previous answers?

A. If a single layer cylindrical coil is wound to a certain number of turns and if a variable condenser is connected to the terminals of this coil, and if this circuit is provided with a detector and telephones, this circuit can be tuned to some given wave length. If now, the number of turns in the coil is progressively increased, then, the wave length remaining constant, it will be found that the variable condenser will have to be progressively decreased in capacity. If again, the number of turns in the coil is further increased, a point will be reached at which no variable condenser at all is necessary to tune the circuit to the given wave length; in fact, the variable condenser can be entirely removed and the circuit will be tuned to the given wave length. Under these circumstances this coil has not only inductance, but also a distributed capacity and such a coil, when connected to a suitable detector, can be tuned broadly [fol. 1125] to certain ranges or bands of wave length, as I have previously mentioned.

If contact should be made at points along this coil say at every fifty turns, it will be found that at each one of these contacts the circuit will be tuned to a different band of wave lengths. If, instead of making contact at a certain number of points, a sliding or continuously variable contact is made, then there will be a continuous tuning or adjustment to all the wave lengths within the range of the coil. The method of separate contacts was the method used in the Telefunken, Atlantic Communication, and Signal Corps sets types A and B. The method of the continuous adjustment is that used, for example, in the Foote-Pierson set, wherein the so-called double-slide tuning coil is used.

Q. 13. You have stated that the secondary coil can be tuned to a desired wave length through the inductance and distributed capacity. Can you refer to any literature indicating that this fact is recognized in the radio art?

A. Yes. In "Circular of the Bureau of Standards", No. 74. Radio Instruments and Measurements, Government

Printing Office 1918, pages 62 and 63, Section 19, "Capacity of Inductance Coils", I find the following:

"19. Capacity of Inductance Coils

"The small capacities between the turns of a coil are of such importance in radio design and measurements that a coil can seldom be regarded as a pure inductance. The effect of this distributed capacity is ordinarily negligible at low frequencies, but it modifies greatly the behavior of a coil at radio frequencies. For most purposes a coil can be considered as an inductance with a small capacity in parallel as shown in Fig. 45. This fictitious equivalent capacity is called the capacity of the coil. Investigations have shown that in ordinary coils its magnitude does not vary with frequency. Thus a coil may in itself constitute a complete oscillating circuit even when the ends of the coil are open."

In the 1924 edition of the same Circular, I find substantially the same description of the capacity of inductance coils on pages 62 and 63, which I will not read.

In "Robison's Manual of Radio Telegraphy and Telephony for Use of Naval Radiomen" by Admiral S. S. Robison and revised by Commander S. C. Hooper, both U. S. Navy, 6th Revised Edition, published in 1924, on pages 337 and 338, I find the following:

"Distributed Capacity of Inductance Coils

"All types of inductance coils possess capacity in addition to the inductance of the coil. This capacity is composed of a number of capacities which exist between turns of wire on the coil, between the ends, between taps or binding posts on the coil, or between the high-potential end of the coil and the walls of the room, or grounded bodies.

"The capacity of an inductance coil is called the "Distributed Capacity C_0 of the coil."

[fol. 1126] (There is now omitted the rest of this paragraph.)

Continuing with the next paragraph, I find:

"The distributed capacity of a coil cannot be ignored when the coil is used in a radio-frequency circuit, nor can the coil be considered as a pure inductance, but must be

treated as if it were an inductance with a small capacity across its terminals. Each coil, therefore, has a definite resonant frequency even when nothing is connected across its terminals, this resonant frequency being determined by the pure inductance L and the distributed capacity C_0 . This is shown, figure 218, where the distributed capacity can be considered as a capacity C_0 across the whole coil."

I omit the following short paragraph.

Mr. Vaill: Counsel for claimant offers in evidence a photostat print of the pages from the Circular of the Bureau of Standards, No. 74, referred to by the witness, including the diagram referred to in the quotation in the last answer as "Fig. 45" and requests that the same be marked "Claimant's Exhibit No. 203".

(Said exhibit marked as requested.)

Q. 14. According to your experience with these sets concerning which you have been testifying, what if any advantage does the presence of the inductance and distributed capacity have in tuning these sets?

A. It permits the usual variable secondary condenser to be omitted, thus economizing space and doing away with an otherwise additional adjustment. In field and portable sets this permits of quicker tuning of the set and a more prompt reception of the incoming signals or message.

It has the additional advantage which I have stated in my previous answers, of providing a circuit that is broadly tuned, rather than sharply tuned, and this is one advantage in the quick picking-up of signals which is to be considered as included in the first part of my answer.

Q. 15. According to your experience, how do you know that the secondary circuit of the Telefunken type GEK 2 receiver was tuned by means of the inductance and distributed capacity?

A. One such set had been returned to Washington for repair and general examination, and during this time I tested and measured the secondary circuit and found that it was tuned by inductance and distributed capacity by measuring the wave length at each of the six contacts. The secondary circuit in this set consisted of the secondary coil of the oscillation transformer, the crystal detector, and a stop-ping condenser, all in series with two pairs of telephones

that could be connected in shunt to the condenser. A variable switch-arm made contact at any desired one of these six contacts. At each one of these contacts there was a small tab or marker giving the range or band of wave lengths to which the circuit was thus tuned at the contact in question. I measured the natural wave length at each of these six contacts and found that it was in general approximately at the middle of the band or range of wave lengths marked at each tab.

[fol. 1127] Q. 16. Do you know whether or not the Telefunken Company has ever issued any instructions as to how to use this type GEK-2 set?

A. Yes, I know that they issued a set of instructions for tuning and operating this set as a part of the instructions for tuning and operating the Signal Corps radio wagon set, of which this receiver was a part.

Q. 17. Can you produce a copy of such instructions?

A. Yes, I produce them herewith.

Q. 18. Will you please point out in these instructions that you have produced any sentence or other matter which is in accordance with your testimony in answer to Q. 15?

A. The instructions which I have produced are for a radio wagon set with a transmitter and a receiver and are entitled "Instructions for Operating Telefunken Wireless Telegraph Field Wagon Set Supplied on Signal Corps Order #9648." On Sheets 3 and 4 of these Wagon Set instructions, I find the following:

"Receiver

* * * "To receive, close the large double pole switch at the top of the receiver.

The plug holes marked with Roman numbers (at the right on the receiver) are connected to taps on the aerial or primary coil.

The wave range on this coil is approximately as follows with a proper aerial."

I omit a short table.

Continuing to quote:

"The turns on the detector or loose coupling coil are variable by means of the switch located on its top, the wave range for each tap being marked.

Either of the two detectors can be used by means of the switch located between them.

For receiving a signal of a known wave-length, the following procedure can be recommended:

1. Use tight coupling.
2. Plug in on the aerial coil.
3. Set the switch on the detector coil at about " $\lambda = 500/1000$ ".
3. Set the switch on the detector coil at about '500-1000'.
4. Turn the condenser very slowly over the entire scale.
5. Change the plug on aerial coil and repeat No. 4. When signals are finally heard, the coupling and the position of the switch on the detector coil are varied until the best results are obtained."

I omit the note of six lines at the bottom of page 4.

Q. 19. Will you please state the source from which these instruction sheets were obtained?

A. I asked for and received the instruction sheets which I have produced, from the late Mr. Richard Pfund, at the time when he was the representative of the Telefunken Company and I note that on the back of each sheet there occurs the following:

[fol. 1128] "The Telefunken Wireless Telegraph Company
of the United States,

111 Broadway—New York, N. Y."

This is a marking put on by a rubber stamp and each sheet was so stamped when I received them from Mr. Pfund.

Q. 20. Have these sheets, which I note are in the form of blueprints, been continuously in your possession since they were given to you by Mr. Pfund?

A. Yes.

Mr. Vaill: Counsel for claimant offers in evidence a photostat print of the sheets of the Telefunken Company instructions produced by the witness, consisting of four sheets of reproductions of typewritten matter and two sheets of diagrammatic drawings, and requests that the same be marked "Claimant's Exhibit No. 204".

(The said exhibit marked as requested.)

Mr. Vaill: Counsel for claimant also offers in evidence a photostat print of pages 337 and 338 of the "Manual of Radio Telegraphy and Telephony" referred to by the witness in his answer to Q. 13, and requests that the same be marked "Claimant's Exhibit No. 205."

(Said exhibit marked as requested.)

Q. 21. Have you found the same or similar instructions for the operation of this radio wagon set of the Telefunken Company in other publications?

A. Yes. In "Plaintiff's Exhibit No. 90, 'Radio Telegraphy 1914'", pages 91 to 93, inclusive; in "Plaintiff's Exhibit No. 91, 'Radio Telegraphy 1915'", pages 92 to 94, inclusive; and in "Plaintiff's Exhibit No. 92, 'Radio Telegraphy'", date not given on the exhibit marking but noted to be from the publication "October, 1916", pages 93 to 95, inclusive; I find the set of instructions similar to that which I have produced in the blueprints "Claimant's Exhibit No. 204".

Q. 22. What is the basis of your statement that the secondary circuits of the type E-4, E-5 and GAHU sets were tuned by changes in inductance and distributed capacity?

A. Sets of these three types had been purchased both by the Signal Corps and by the Navy Department and, on various occasions, were available for use, test and measurement in Washington. On these various occasions I measured and tested the secondary circuits of these receivers. I found them tuned circuits, being so tunable by inductance and distributed capacity.

Q. 23. Why did you have occasion to make the measurements of wave length of the secondary circuits of the Telefunken Company receivers types GEK-2, E-4, E-5 and GAHU?

A. For two reasons; the first was that it was a part of my duty to know the various types, connections and methods of tuning, and methods of using the Signal Corps sets and, in general, the sets of that time; the second reason was that while designing Signal Corps sets types A and B, I planned to use a secondary circuit that was to be tuned by inductance and distributed capacity. During the course of this work there was some discussion in the Signal Corps as to whether or not this method of tuning could be used; al-[fol. 1129] though I knew that the Telefunken sets had

secondary circuits that were tuned by inductance and distributed capacity for different wave lengths by the suitable selection of the contact points along the secondary coil, there were some men who believed that this choice of contact was made for some purely mechanical reason and not for any electrical reason. And in order to confirm the facts which I had noted in the design of these various sets, I proceeded to measure and test the secondary circuits of all of these types of receivers.

In every case I found that they confirmed my belief that these secondary circuits were thus tuned by inductance and distributed capacity.

Q. 24. What knowledge have you of instruction sheets issued by the Telefunken Company relating to receiving sets of the type E-4, E-5 and GAHU?

A. There were instruction sheets issued by the Telefunken Company for the operation of these sets, including circuit drawings, and so forth.

Q. 25. Can you produce such sheets and, if so, please state the source from which you obtained them?

A. I can produce some parts of these instructions, which I hand you herewith. These instructions were obtained by me from Mr. Pfund of the Telefunken Company, during the last of 1911 or the early part of 1912. The sheets have been continuously in my possession ever since.

I may add that the sheets in question refer to the receiver type GAHU, not specifically to E-4 and E-5; however, these latter two sets had circuit connections practically the same as GAHU.

Mr. Vaill: Counsel for claimant offers in evidence the six photostatic prints produced by the witness in answer to the last question, and requests that the same be marked "Claimant's Exhibit No. 206."

(The exhibit is marked as requested.)

Q. 26. Will you please point out in these sheets you have produced, "Claimant's Exhibit No. 206", anything that confirms your testimony as to the operation and tuning of this GAHU type set?

A. On the second sheet, No. 167, there is, on the right hand third of this sheet, a circuit diagram of the GAHU receiver. The primary circuit is shown as consisting of the antenna, a variable inductance and the ground, all con-

nected in series, and a variable condenser, which may be connected either in series or in shunt to the primary variable inductance. Thus the primary circuit can be tuned by changes in inductance, or variable condenser, or both. There are two secondary circuits shown on this sheet, one of which is indicated by an arrow by the words "Detector Coil" and the other, or alternative secondary circuit is indicated just below, and to the right of the other, by an arrow with the words "Secondary Coil". The latter secondary circuit, to-wit, the one marked "Secondary Coil", is tuned both by a variable inductance and a variable condenser and is not the type of circuit to which I have referred mostly in my previous answers in describing secondary tuning by inductance and distributed capacity. The secondary circuit to which I have repeatedly referred, with inductance and distributed capacity, is the one shown marked with the [fol. 1130] words "Detector Coil". This secondary circuit is seen to consist of a variable inductance, either one of two detectors and a telephone condenser, all connected in series with one or two pairs of telephones in shunt to the condenser.

Referring to sheet No. 162A the same two secondary circuits are shown on a somewhat enlarged scale; on these two sheets the secondary circuit diagram shows connection is made by an arrow resting on one of the turns of the secondary inductance. This is the conventional way of indicating a variable inductance.

Referring now to the left hand side of sheet 162A and near the top and center of this part, is seen an arrow marked "Sec. Coil" and on the lower parts of this secondary coil are indicated six holes, three on one side and three on the other side of the center line, and to two of these holes there is indicated a line with an arrow, thus indicating in another slightly different manner that there are six holes for the contacts, and that contact may be made at any one of these six holes of the secondary coil. From my knowledge of this set and its actual practical use, I know that the variable contacts shown in the "Detector Coil" circuit of sheets 167 and 162A were really sockets which were connected to six different points on the secondary coil, and that the variable contact on these sheets was actually a plug-connection at the end of a flexible wire. Referring now to the last of the unnumbered sheets showing a receiving set, which I recognize as being type GAHU, I recognize the coil which

is shown lying at an angle with the horizontal line, as being the "Detector Coil" which I referred to on the other sheets of this exhibit. On the upper side of this coil, and at the left, near the edge, can be seen a short piece of the flexible wire and the plug for making the variable contact on this coil; and both on the upper and lower edges of the frame of this coil can be seen three, at least, of the variable sockets previously mentioned in this answer. In other words, I recognize that the secondary circuit of this receiver as being one tuned by inductance and distributed capacity and that there are six contacts on this coil, made by plug and socket, covering six adjacent bands or ranges of wave length.

Q. 27. Can you produce instruction sheets relating to type E-4 and E-5 sets, and if not, for what reason?

A. No, I cannot produce these sheets, for the reason that although both sets of instructions for E-4 and E-5 were given to me by Mr. Pfund, together with those for GAHU, I have been unable to find these sheets in my personal files from which I drew the sheets included in "Claimant's Exhibit No. 206".

Q. 28. Which, if any, of the sets of the Atlantic Communication Company were capable of having the secondary circuits tuned by changes in inductance and distributed capacity?

A. The same sets as had been previously furnished by the Telefunken Company, to-wit, E-4, E-5 and GAHU. By this answer I mean the same kinds of sets.

Q. 29. Will you please describe the general circuit arrangement and the manner in which the secondary circuit was tuned, as to the Signal Corps pack sets 1915 type, re-[fol. 1131] ferred to by Mr. Loftin on page 1116 of the printed record?

A. This set is more correctly known as the type C receiving set. I may add at this point that there was a later and slightly improved set of the same kind that was known as type D receiving set; the circuit arrangements of the two sets are practically the same, and a description of type C will really suffice for both sets.

Type C set has two tuned and coupled circuits provided with crystal detector and high-resistance telephones. There are two kinds of connections provided for this set, one for the shorter wave lengths and another kind for the longer wave lengths.

Referring only to the shorter wave lengths, the primary circuit consisted of the antenna, a variable part of the primary inductance of the oscillation transformer and the ground or counterpoise. This circuit was tuned by means of two variable switch-arms, one making contact on any one of twenty-four contacts having large changes or steps in inductance, and the other making contact on any one of twenty-four contacts making the small changes in inductance in between the large changes. The secondary circuit was coupled to the primary circuit by means of two condensers, and for this reason this type of coupling has long been known in the art as a "condenser coupling". The secondary circuit consists of the secondary inductance coil of the oscillation transformer, the crystal detector, the stopping condenser, all in series, and having the telephones in shunt with the condenser. This secondary coil was designed to have inductance and distributed capacity similar to that described in types A and B of the Signal Corps sets, and others mentioned in my testimony, and was tapped at twenty-four points along its turns, thus permitting tuning by inductance and distributed capacity to twenty-four adjacent bands or ranges of wave lengths.

Referring now only to the longer wave lengths, change was made by a switch to another kind of connection. The primary circuit and its method of tuning is the same as that for the shorter wave lengths. The secondary circuit is now directly coupled to the primary or directly-connected, as it is sometimes known, using the auto-transformer type of circuit, in which the ratio of turns is one-to-one. The secondary circuit now consists of the same turns as are in the primary circuit, in series with the two coupling condensers, the telephone condenser, and the detector and telephone in shunt to each other. The secondary circuit then has inductance and some distributed capacity which is in series with three other local capacities and the telephones in shunt to the detector. The secondary circuit is thus tuned at the same time that the primary is tuned, and by the same means; that is, the two variable switch-arms.

Q. 30. What circumstances led up to the construction where the kind of connection at long wave lengths was different from that at short wave lengths?

A. When the condenser type of coupling between the primary and secondary circuits was extended to the longer

wave lengths of this set, it was found that such a set was somewhat inefficient. For this reason an effort was made to design, for the longer wave lengths, a magnetically coupled [fol. 1132] set. Thus, at the shorter wave lengths the circuits would be condenser coupled and at the longer wave lengths magnetically coupled. During the comparisons between the condenser coupled and the magnetically coupled circuits at the longer wave lengths, it was found as a matter of experimental discovery, that the direct-connected circuits which I have just described, were more efficient than either the condenser coupled or magnetically coupled circuits within the space allotted for this receiving set. It was for this reason that the directly-connected type of set which I have just described was finally adopted for both the type C and type D receiving sets.

Q. 31. Can you refer to any exhibits in this case which confirm your understanding of the circuit connections of the type C set which you have referred to in your preceding answers?

A. Yes. I refer to "Plaintiff's Exhibit No. 91", page 119 and "Plaintiff's Exhibit No. 92", page 125. These two pages are apparently identical, and in the upper half of both there are the circuit connections for the short wave lengths which I have described, and in the lower half the circuit connections for the longer wave lengths, as I have described.

Q. 32. Now referring to the Foote-Pierson Company type of Signal Corps pack sets, will you please describe the general circuit arrangements and the method of tuning the secondary circuit of this set?

A. This set is of the type known as a "double slide tuning coil set" and consists of two tuned circuits that are directly-connected or directly coupled. The primary circuit consisted of the antenna, a variable or adjusted part of the inductance coil and the ground or counterpoise, all in series. The secondary circuit is directly coupled by the auto-transformer type of connections, in which the ratio of the turns is variable. The secondary circuit consisted of an adjustable or variable part of the inductance coil in series with a crystal detector and a stopping condenser, and having the telephones and potentiometer in shunt to this condenser. By using a large number of turns in the secondary circuit, there was provided inductance and distributed capacity such that the secondary circuit could be tuned to a continuous band or range of wave lengths. This tuning by

inductance and distributed capacity was limited to a narrower band or range than the later types of Signal Corps sets which I have described, to-wit, types A and B.

I may add that this early type of set, with its single inductance coil, is the most rugged and compact type of set that could be built, and it was for this reason that it was used in the early Signal Corps field or pack sets. Later it was replaced by sets using the oscillation transformer, which were more useful and tunable over a wider range or band of wave lengths.

Q. 33. Referring again to the receiving sets of the Atlantic Communication Company and to the Signal Corps pack sets of 1915, which you have also designated as type C sets, what facts, within your experience, have a bearing upon the following statement made by defendant's witness Loftin, found on page 1116 of Volume 3 of the Printed Record beginning just above the middle of the page:

[fol. 1133] "In some of the above types I find that at the receiving station the secondary circuit is of the type known as 'untuned'. That is, there is no provision made for varying the time period of the secondary of the receiving circuit to correspond to the frequency of the incoming signal, the receiver depending upon tuning the primary or open circuit only. Of the above types the following have untuned secondary circuits at the receiver.

"Atlantic Communication Co. type.
"Signal Corps pack set, 1915 type."

A. From my experience with, and knowledge of, these sets, as amply described in my previous testimony, I know that the statement is wrong in that the secondary circuits are tuned, there is a provision for varying the time period, and that the receiver does not depend only on the tuning of the primary circuit.

Q. 34. Will you also refer to the following statement made by defendant's witness Loftin, as found on page 1117 of the Printed Record, near the top of the page, regarding the same sets mentioned in the previous question, and state what facts, if any, within your experience, have a bearing on said statement:

"I have also named two types in the above group which have a secondary circuit at the receiving station which is

not tunable. That is, the secondary circuit is designed to remain fixed in frequency or natural time period to be used with a primary or absorbing circuit which is tunable through a wide range of natural time periods."

A. From my experience with, and knowledge of, these sets, I know that the statement is wrong, in that the secondary circuits of these two sets are tunable, and they are not designed to remain fixed in frequency.

Q. 35. Will you please refer to the following statement of defendant's witness Loftin, found on page 1117 of the Printed Record, and state what facts, if any, within your experience, have a bearing on said statement; particularly as concerns the Signal Corps pack set of 1915:

"In the 'long wave' type illustrated in plaintiff's Exhibit 91, the secondary circuit is in no wise tunable," * * *

A. From my experience with, and knowledge of, this set, as amply described in my previous answers, I know that this statement is wrong, in that the secondary circuit is tunable.

Q. 36. Please refer to the following statement by defendant's witness Loftin, found on page 1119 of the Printed Record and state what facts, if any, within your experience, have a bearing thereon:

"I also find that in the following types of the group now under discussion, the receiving stations have untunable secondary circuits:

"Telefunken type.

"Foote-Pierson type.

"These two types having untunable secondary circuits at the receiving station are therefore subject to the same comments of mine in connection with the previous group, wherein a number of receivers had tunable secondary circuits."

A. From my experience with, and knowledge of, these two kinds of sets, as amply shown in my previous answers, I know that the statement is wrong, in that both types of sets have tunable secondary circuits.

Q. 37. In addition to the Signal Corps sets and the sets of the Telefunken and Atlantic Communication Companies,

to which you have referred in your previous answers as having secondary circuits which were tunable and were actually tuned to the incoming signals, did the Signal Corps have sets in which the secondary was untuned and untunable?

A. In my experience in Signal Corps work, which has covered a period of at least a dozen years and more, I know of no receiving set in which the secondary circuit was untuned and untunable.

I may add that there was one, and only one, set in which the secondary circuit was untunable in the sense that there was no variation provided for changing the wave lengths. This occurred in the 1909 Telefunken two-trunk pack set. Part of this set had been returned to Washington for a general overhauling and I examined and tested the secondary circuit of this set. The secondary circuit consisted of an inductance coil of fixed inductance as the secondary of an oscillation transformer, crystal detector, and stopping condenser, all in series, and having the telephones in shunt to the condenser. I measured the natural wave length of this secondary circuit and found it to be slightly over 300 meters and also found that the most useful range of wave lengths of the transmitting part of the set was from 250 to a little less than 400 meters. In other words, the secondary circuit of this receiver was tuned by inductance and distributed capacity to a single band of wave lengths approximately within the center of the most useful band of transmitting wave lengths. Under these circumstances this secondary circuit is not an untuned circuit, but is tuned by fixed adjustments to the best wave lengths of a transmitter of another pack set with which it is in communication.

Q. 38. Will you please refer to "Claimant's Exhibit No. 204" which you produced, and which is entitled "Instruction for Operating Telefunken Wireless Telegraph Field Wagon Set Supplied on Signal Corps Order No. 9648" and state whether or not you ever saw and operated such a set?

A. I saw the Field Radio Wagon Set referred to at Fort Myer, Virginia, in the late Fall of 1909, just before the set was shipped to the West.

The receiving set was provided with two pairs of telephones and the Signal Corps operator in charge wore one pair and I wore the other, and I tested this receiving set with him, listening to such stations as could be heard at that time.

Later the Signal Corps operator demonstrated for me the operation of the engine and the transmitter, but I did not, personally, operate either part.

Q. 39. Were the instruction sheets for the corresponding instructions of "Claimant's Exhibit No. 204" adopted by the Signal Corps as evidenced by publications referring to [fol. 1135] Signal Corps work; if so, will you kindly refer to them?

A. Yes, I refer to "Plaintiff's Exhibit No. 90", pages 91 to 93, inclusive, which is "Circular No. 1, Office of the Chief Signal Officer, 1914, Radio Telegraphy U. S. Signal Corps 1914". I refer also to "Plaintiff's Exhibit No. 91", pages 92 to 94, inclusive, which is practically a later edition of "Circular No. 1", being dated May, 1915. I further refer to "Plaintiff's Exhibit No. 92", pages 93 to 95, inclusive, which is entitled "War Department Office of the Chief Signal Officer, 1916 Radio Telegraphy U. S. Signal Corps Revised October, 1916".

Q. 40. Will you please refer to "Claimant's Exhibit No. 206", which was produced by you, comprising "Diagrams and Instructions for Type 0.5 T.K. (1 KW) Telefunken Set" and state whether or not you ever saw and operated a set similar to the one illustrated in said exhibit?

A. Yes, I saw this set, or the same type of set, in the Coast Artillery Station at Fort Monroe, Virginia, in the Summer of 1912, and I operated both the receiving part and the transmitting part.

Q. 41. In operating this set, to what extent did you vary the adjustable portions to tune to the wave lengths desired?

A. I simply followed the Telefunken Company's instructions as contained on sheet 167 of "Claimant's Exhibit No. 206", contained within the insert entitled

"Directions for Operating

"1. Set the plugs on primary inductance at points indicated on drawing = 152.

2. This will result in a certain definite wave length or period in the primary circuit and all that remains to be done is to put the aerial circuit in resonance with the primary circuit by means of the aerial variometer (V).

3. This is done by varying the number of turns and relative position of coils X and Y both of which turn about axis C.

4. To reduce the energy (range) of the transmitter reduce the number of operative gaps in the spark-gap (G) at the same time reducing the generator voltage.

5. As the clearest signals are obtained with a certain definite generator voltage at the terminals of the spark-gap (G) great care must be taken to neither make this voltage too high (which would tend to produce an arc) or too low (which results in imperfect signals)."

I did not use the instructions of paragraph 6, which only concerns the maintenance of the set.

Q. 42. Testimony has been given in this case by defendant's witnesses to the effect that the primary and secondary or antenna circuits of a quenched spark transmitter are not tuned to resonance, but are slightly detuned. Will you please state your experience in this regard as concerns any of the Signal Corps, Navy or Coast Artillery sets which you have seen or operated? You may also refer to any printed matter on this subject which may contain instructions for the operation of such sets.

A. I know of no such detuning in any of the sets mentioned in the previous question. I have made hundreds of measurements of the wave lengths of quenched spark transmitters and I have never noted this detuning.

Referring specifically to the matter of instructions concerning detuning, I refer to the book "Robison's Manual of Radio Telegraphy and Telephony for Use of Naval Radiomen" by Admiral Robison and Commander Hooper, both U. S. Navy, Sixth Revised Edition, 1924, pages 539 and 540.

I refer to the following:

"It is very important that (a) both circuits be in resonance; (b) proper voltage for the number of gaps used be supplied; (c) best coupling exist between the primary and secondary. *In no case should the antenna circuit be detuned* (thrown out of resonance with the primary), because (a) there will be a reaction between the two circuits and two waves will be radiated which can be found on a wavemeter coupled to the antenna circuit; (b) the gap will not quench properly, thereby heating, and power will be retransferred from the antenna to the primary, and back again to the antenna, and the decrement will be increased due to this retransfer of power. In other words, the utility and efficiency of the quenched-spark system will be entirely lost.

"Whenever it is desired to transmit on *maximum power*, special adjustments should always be made with a view to obtaining maximum output and maximum efficiency, thereby reducing injury to the transmitter. The voltage number of gaps, coupling, and tuning of the antenna circuit to the primary circuit should be carefully adjusted" (*italicized matter is in heavy type in original text.*)

.

Q. 43. In the measurement of the wave lengths of quenched gap transmitters by you in connection with the Signal Corps work, to what extent did you find that detuning between the primary and secondary circuits of the transmitter was necessary?

A. I have made hundreds of measurements of wave lengths of quenched spark transmitters and have never noted that there was any detuning, or that detuning was necessary; in other words, the circuits were in resonance.

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[fol. 1137] Cross-examination.

By Mr. Edwards:

X Q. 44. In your direct examination you referred to certain Telefunken sets and certain Signal Corps sets to which reference was made by Mr. Loftin in his testimony at printed pages 1116 to 1119, inclusive. Do you understand that Mr. Loftin was referring to sets previously described by claimant's witness Waterman in this case?

A. Yes, in part.

X Q. 45. Do you understand that he was referring to any sets other than those described by Mr. Waterman?

A. Without having read the testimony of other claimant's witnesses for a very considerable length of time, it is my understanding that the sets included at least some of those mentioned by other witnesses.

X Q. 46. Are the sets referred to by you in your direct examination, the same sets as the ones referred to by Mr. Waterman?

A. In part, yes.

X Q. 47. Have you made reference to any other sets or types of apparatus than those referred to by Mr. Waterman?

A. I have referred to types of sets such as I remembered from witness Waterman and others, and, without having read Mr. Waterman's testimony for a long time, I consider that the types mentioned by Mr. Waterman include those of the other witnesses, and with this understanding, I consider the types mentioned by Mr. Waterman as including also the types mentioned by the other witnesses.

X Q. 48. Which, if any, of the types referred to by you, were referred to by Mr. Waterman?

A. Without having read Mr. Waterman's testimony for a long time, I consider that I have included the same types as were included by Mr. Waterman.

X Q. 49. Referring to the Telefunken Company's apparatus, specified by you in answer to Q. 9, will you state wherein any of the types mentioned by you differ from the schematic representation of circuits "Plaintiff's Exhibit No. 79", introduced by Mr. Waterman and printed opposite page 180 of the Printed Record?

A. The circuits mentioned in "Plaintiff's Exhibit No. 79", marked "E-4 Receiver" are of the same type as in the Telefunken sets in question.

X Q. 50. Do you mean that the receivers of all of the Telefunken sets referred to in your answer to Q. 9, were like the type E-4 receiver illustrated in "Plaintiff's Exhibit No. 79"?

A. Of the same general type.

X Q. 51. You will note that in his exhibit "No. 79", Mr. Waterman illustrates the E-5 receiver as having a condenser h' , whereas said condenser is not present in the E-4 receiver as illustrated by Mr. Waterman. Do you understand that the types GEK-2, E-5 and GAHU, referred to in your answer to Q. 9, did, or did not, have this condenser?

A. As stated in my direct examination, types E-5 and [fol. 1138] GAHU had two types of secondary receiving circuits, one type with a secondary tuning condenser as h' , and the other a different secondary coil without the tuning condenser; that is, the secondary circuit was therein tuned by means of the inductance and distributed capacity of the secondary coil without the secondary variable tuning condenser.

X Q. 52. Do you mean that some of the GEK-2, E-5, and GAHU receivers had the condenser h' and some did not?

A. The type GEK-2 did not have the secondary variable

tuning condenser h' , but as stated in my previous answers, E-5 and GAHU were furnished with two different types of receiving circuits. That is, each set had the equivalent of both E-4 and E-5, as shown in "Plaintiff's Exhibit No. 79".

X Q. 53. Will you explain what you mean by "equivalent" in your last answer?

A. The same general type of circuit, E-5 being tuned by a variable condenser and E-4, not being so tuned.

X Q. 54. Take the case of the E-5 receiver, was that provided with both of the circuits illustrated by Mr. Waterman; that is to say, both of the receiver circuits illustrated by him?

A. Yes, in the sets that I saw.

X Q. 55. Was the condenser h' present in these sets?

A. Yes.

X Q. 56. Will you explain how the set was so arranged that it sometimes used the circuit of the E-5 receiver and sometimes the circuit of the E-4 receiver?

A. One set of coils was used as in E-5, and one other coil for use as in E-4, and the necessary connections were made by plugs and sockets.

X Q. 57. And the set was provided with two different coils j^2 and j^2 ; is that correct?

A. No, there was a set of coils for j^2 of E-5 and only one coil j^2 for E-4, and it was the coil of j^2 of E-4 that had the band of wave lengths marked by a tab or marker at the several sockets.

X Q. 58. And in the same set there would be present the set of coils and condenser h' for the E-5 hook-up, and another coil, j^2 , in the E-4 hook-up, without the condenser h' ; is that correct?

A. They would not be present in the sense of being connected into circuit, but were separate units to be into circuit one at a time.

X Q. 59. Then, am I correct in understanding that the type E-5 receivers were provided with two units, one of which had the circuit arrangement as shown in the E-5 receiver of Mr. Waterman's diagram, "Plaintiff's Exhibit No. 79", and the other of which had the circuit of Mr. Waterman's diagram marked "E-4 Receiver" in the same exhibit, and that these units were adapted to be used alternately?

A. Yes.

X Q. 60. And is the same true of the GAHU receiving sets?

A. Yes.

X Q. 61. Referring to your answer to Q. 32, is the Foote-Pierson set there referred to, the same as the one diagrammatically illustrated by Mr. Waterman in his "Plaintiff's Exhibit No. 102" opposite page 196 of the Printed Record?

A. It is the equivalent of that set, with the understanding that the coil in black and the coil in red are actually one and the same coil, and with the further understanding that the coil in black represents the tuning of the primary [fol. 1139] circuit and the coil in red the tuning of the secondary circuit, which in the actual set, was directly coupled as stated in my direct examination. I further note that there is a slight error in the green circuit in the diagram, wherein the condenser in the green circuit has evidently been misplaced in the reproduction.

X Q. 62. Will you explain how this condenser has been misplaced and where it should be?

A. Short circuit condenser in green as it is shown, insert another condenser in red just below the detector marked in black with T, change the green line wherein the condenser in green has been short-circuited to the point just underneath the base of the detector; this will correct the minor mistake which I have pointed out.

X Q. 63. In your answer to Q. 4, and in other parts of your deposition, you refer to later types, A, B, C and D of receivers used by the Signal Corps; are they the same types that are referred to by Mr. Waterman in his answer to Q. 23, at page 203 of the Printed Record?

A. In the first line of the answer as printed on page 203, I note an apparent mistake in printing, in that it reads "model L913"; I assume this means "1913" and, if so, the 1913 and 1914 receiving sets are the same as type B referred to in my previous answers. In answering this question I assume that only these two receiving sets are inquired about and, if so, my answer is as already given.

Q. 64. Mr. Waterman's answer to Q. 23, you will note, states that this set which you identify as "type B" is the same in all substantial particulars as the National Electric Supply Company set illustrated by him schematically in "Plaintiff's Exhibit No. 80", opposite page 192 of the

Printed Record; is this in accordance with your recollection?

A. Types A and B are like the receiving station of "Plaintiff's Exhibit No. 80", opposite page 192.

X Q. 65. How did the types C and D compare with the set illustrated in "Plaintiff's Exhibit No. 91", opposite page 204 of the Printed Record?

A. Types C and D are correctly represented by "Plaintiff's Exhibit No. 91", opposite page 204.

X Q. 66. To what band of frequencies were the type E-4 Telefunken receivers, the Foote-Pierson receiver illustrated in "Plaintiff's Exhibit No. 102" and the long wave length types C and D Signal Corps receivers tuned respectively?

A. I do not now exactly recall the band of E-4, but it was about 300 to at least 2400 meters. The Foote-Pierson receiver was tuned to a very much narrower band, from wave lengths of 250, or slightly more, to nearly 400 meters, and for types C and D from about 1,000 to a little over 2,000 meters.

X Q. 67. Do you not consider that if the long wave length type C receiver is receiving wave lengths of 500 meters, that the receiving circuit tuned to from 1,000 to 2,000 meters would be out of tune with the incoming frequencies?

A. Your question presupposes a condition never realized in practice because, for short waves, as 500, the long-wave circuit arrangement was never used.

X Q. 68. Please disregard the matter of whether or not this condition would be realized in practice, and with that [fol. 1140] understanding, answer the preceding question.

A. I do not see how I can answer that question, inasmuch as it presupposes a condition which I have never encountered in my experience; that is, I have never attempted to receive a wave length of 500 meters with the circuit arrangement of the long wave circuit.

X Q. 69. If the receiving circuit is tuned to a band of frequencies ranging from 1,000 to 2,000 meters, at what wave length was the circuit most resonant?

A. It would be most resonant to a succession of bands of wave lengths, depending upon where the variable switch-arms made contact; and I cannot now tell the band wave length for each of these various contacts; that would involve at least several hundred combinations.

X Q. 70. If one circuit is tuned to a wave length of 500 meters and another circuit is tuned to a band of frequencies ranging from 1,000 to 2,000 meters, do you consider that they are in resonance?

A. No.

X Q. 71. How close should the frequencies approximate in order to be in resonance, in your opinion?

A. The wave length of one circuit had best be within the band of the other circuit; in some cases the band or range on either side of the first-mentioned band might give very nearly equal results; that would depend, to a considerable extent, on the type of transmitter; thus, if the transmitter is very broadly tuned as to its radiated wave lengths, nearly equal response might be found on two adjacent bands of wave lengths.

X Q. 72. In your direct examination you mentioned having tested certain of these Telefunken sets; did you make any written report of these tests?

A. Yes, although they may have been somewhat informal, being given in a memorandum.

X Q. 73. Were any of these reports of an official nature?

A. All official.

X Q. 74. Were they of such character as could be found in the files of the Signal Corps?

A. Yes.

X Q. 75. To whom were they rendered, and when?

A. Either to the Chief Signal Officer, or to the Officer in Charge, immediately following the tests.

X Q. 76. Do you recall the name of the officer or officers to whom the reports were rendered?

A. Only in part, because there were many officers in charge at different times.

X Q. 77. Were the reports delivered to the Chief Signal Officer in person?

A. No.

X Q. 78. What was the official title of the officer to whom the reports were delivered?

A. They might be according to several different titles as Chief Signal Officer, Assistant to the Chief Signal Officer, Officer in Charge, Signal Corps Laboratory and doubtless, in many cases, simply in the form of a memorandum to lieutenant, captain, major, so and so.

X Q. 79. To what officer did you report during the time that these reports were being made?

A. To several officers, all of whose names it would be difficult now to recall.

X Q. 80. Can you give the names of any of them?

A. Yes. The then Major Squier, now Major-General U. S. Army, retired; Brig.-General Allen, U. S. Army, now [fol. 1141] retired; the then Major Russel, later Major-Gen. Russel, U. S. Army, retired, who has recently died; the then Capt. Wallace, now Colonel Wallace; the then Lieut. Olmstead, now Major Olmstead; the then Capt. Voris, now Colonel Voris; the then Major Saltzman, now Major-Gen. Saltzman, the present Chief Signal Officer of the Army; the then Capt. Black, now Major Black; and many others whom I do not now recall.

X Q. 81. Can you not recall the name of the particular officer, or the time when you reported the results set forth in your answer to Q. 11?

A. To the best of my knowledge it was the then Major Russel, later Major-Gen. Russel.

X Q. 82. Can you reproduce the resonance curves for the wave lengths as set forth in your answer to Q. 11?

A. No, I have no material whereby I could give this information; and I may add that both galvanometer deflections and telephone tests were used in this work, but that no galvanometer measurements were made in the tests when the telephone was the detecting instrument.

X Q. 83. When the telephone was used, did the tests consist in listening in at different wave lengths and determining that there was no observable difference between 300 and 450 meters, 450 and 700 meters and 700 to 1200 meters?

A. There was an observable difference, but so slight that the circuit was considered tunable over the band in question.

X Q. 84. How was this observable difference determined?

A. By two observers listening in and noting the change over the band in question.

X Q. 85. At what frequency was the loudest response heard in each of the band of frequencies mentioned in your answer to Q. 11?

A. In general, about in the middle of the band.

X Q. 86. Was there a marked difference in the response above and below the limits of the respective bands?

A. In some cases yes, and in other cases no; thus in the type D receiver at short wave lengths, there were 30 studs instead of 24, as in type C, it was not always possible to

adjust to the same stud, but it might vary by a stud or two, particularly if the transmitter was broadly tuned.

X Q. 87. Could you not draw resonance curves illustrating approximately your present recollection of the degree of response obtained at each of the contacts as referred to in your answer to Q. 11?

A. No, I couldn't undertake to do it so many years after the time of the tests.

X Q. 88. And these tests were about how many years ago?

A. There were a great many tests, beginning in 1911, and continuing from time to time, until 1914 or 1915.

X Q. 89. Is it not fair to say that your present testimony is merely your recollection, after upwards of ten years, as to the degree of response from each of the settings of contacts referred to in your answer to Q. 11?

A. It is my best recollection, but a recollection that, in some respects, is very vivid; thus type D was an improvement essentially over type C, in that, as the transmitters improved we found it necessary to improve the receivers, and for that reason the number of studs for the short wave connection was increased from 24 to 30.

[fol. 1142] X Q. 90. Can you produce any documentary evidence in support of your recollection as testified to in this case?

A. I have produced "Claimant's Exhibit No. 204", which supports my recollection.

X Q. 91. Can you produce any documentary evidence in support of your recollection as expressed in your answer to Q. 11?

A. "Claimant's Exhibit No. 204" is part of such evidence and also "Claimant's Exhibit No. 206".

X Q. 92. Can you produce any other documentary evidence in support of the statements in your answer to Q. 11?

A. In general it would be contained in "Plaintiff's Exhibits Nos. 90, 91 and 92" which are publications of the Signal Corps.

X Q. 93. Referring to your answer to Q. 11, and assuming that at the third contact the point of greatest response is about midway between 700 and 1200 meters, that is to say, at 950 meters, if the instrument is receiving frequencies of 700 meters, do you consider that the receiving circuit is in resonance with the incoming frequencies?

A. Inasmuch as the tuning in that band is broad, resonance exists over a considerable number of wave lengths

or, at least, approximate resonance and, under the conditions existing in the actual set, the circuits were substantially in resonance.

X Q. 94. I notice that you refer to "approximate resonance" and "substantially in resonance"; can you give us any idea as to how you determine whether two circuits are in approximate or substantial resonance?

A. Referring specifically to these receiving sets, if the secondary circuit gave the same, or nearly the same, intensity of signal over a certain range or band of wave lengths, then, being thus broadly tuned, it would be approximately or substantially in resonance over its band of wave lengths.

X Q. 95. Is it your understanding that with any adjustment of the Telefunken E-4 receiving circuit, the Foote-Pierson pack set, "Plaintiff's Exhibit No. 102", or the long wave length type C receiving set, the product of the inductance and capacitance of the antenna circuit is exactly the same as the product of the inductance and capacitance of the receiving set?

A. In the sets in question, I have never measured the product of the inductance and distributed capacity of the secondary circuit, but I did measure only its wave length and that wave length was not sharply defined, but rather was broad, and for that reason would receive over a range of wave lengths of the primary circuit where the product of the inductance and capacitance was varied over some width of band of wave lengths; in other words, I cannot, categorically, answer your question yes or no.

X Q. 96. Do you wish to be understood as testifying or expressing any recollection of whether or not the product of the inductance and capacitance of the antenna circuit was equal to, or approximately equal to, the product of the inductance and capacitance of the receiving circuit in any of the types referred to in X Q. 95, at all settings of the receiving circuit.

A. As I have stated in my previous answers, I did not measure the inductance and distributed capacity of the secondary circuits of the receivers, but I did measure the wave lengths, and I can only express my answer in terms [fol. 1143] of my experience with these sets by stating that these secondary circuits were in tune broadly, or within a certain band or range of wave lengths, with the incoming signals.

Redirect examination.

By Mr. Vaill:

R. D. Q. 97. Referring to your answer to X Q. 62, will you please consider the circuit connections indicated in "Claimant's Exhibit No. 98", and state whether or not the corrections which you suggest being made in "Plaintiff's Exhibit No. 102" are in accordance with the circuits indicated on "Claimant's Exhibit No. 98"?

A. I intend the correction to "Plaintiff's Exhibit No. 102" to make it the same as the circuit indicated in "Claimant's Exhibit No. 98".

R. D. Q. 98. Referring to Mr. Loftin's testimony on page 1116 of the Printed Record, particularly the part quoted in connection with Q. 33 on your direct examination, will you state whether or not any of the pack sets which you referred to on your direct examination were not included within the said sets referred to by Mr. Loftin?

A. The quotation refers only to "Signal Corps pack set, 1915 type", but in my direct examination I referred to types A and B which, if I understand your question, must be additional to the so-called 1915 type.

R. D. Q. 99. Please state whether or not, according to your recollection, the types A and B sets, just referred to by you, were such sets as mentioned by Mr. Loftin on page 1116 of the Printed Record as "National Electric Supply Company Type, Field Radio Pack Set, Plaintiff's Exhibit 80"?

A. In my answer to X Q. 64 I stated, "Types A and B are like the receiving station of 'Plaintiff's Exhibit No. 80', opposite page 192."

Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

Deposition closed.

Deposition of Frederick W. Lehr, for Claimant, Taken at New York, N. Y., on the 13th day of October, A. D. 1926

Appearances: Same as before.

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence,

whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry, and whether, and in what degree, you are related to the claimant.

Answer: My name is Frederick W. Lehr; my age is 44 years; my residence is 21 Victory Boulevard, St. George, Staten Island, New York; occupation, with the Radio Corporation of America; I have no interest, direct or indirect, in this claim, and I am not related in any way to the claimant herein.

Direct examination.

By Mr. Vaill:

Q. 1. Were you ever connected with the United States Navy, and if so, where, and during what period?

A. I was connected with the United States Navy as a Civilian Radio Electrician, at the Norfolk Navy Yard, Virginia, from April, 1917, to July, 1922.

Q. 2. What were your duties at the Norfolk Navy Yard?

A. My duties at the Norfolk Navy Yard were the installation, repairs and calibration of transmitters and receivers on the U. S. war ships.

Q. 3. What experience did you have with open-gap short-wave transmitting sets while connected with the Norfolk Navy Yard during the years 1917 and 1918?

A. My experience with short-wave spark transmitters during the years 1917 and 1918 was the installation of the inter-fleet 126 meter sets which were placed on the war ships to be used with the Grand Fleet in Foreign Waters.

Q. 4. What was the wave length at which these sets you have referred to, were intended to be used?

A. These sets were calibrated to be used with the wave length of 126 meters.

Q. 5. How many of these short-wave transmitting sets did you install or had already been installed on U. S. war ships while you were at the Norfolk Navy Yard?

A. I installed two or three complete transmitters while at the Navy Yard during the years 1917 and 1918, and also made repairs and calibrations to a number of other sets that had been installed previously in other Yards, including the Utah, Nevada, Oklahoma and Arkansas.

Q. 6. To what extent did you have occasion to operate these short-wave transmitting sets installed on United States war ships while at the Norfolk Navy Yard?

A. I had occasion to operate these sets after installation and repairs had been made, as each set had to be calibrated to the wave length of 126 meters; this was done by means of a standard wave meter, and by pressing the key we could then detect if the transmitter was in resonance.

Q. 7. On page 1137 of the Printed Record in this case defendant's witness, Mr. Loftin, states as follows:

"I have in recent years examined the records of purchases of radio apparatus of both the United States Army and the United States Navy since 1910, and while an extremely large number of sets were purchased since that date, particularly during the war, I do not recall a single instance of purchases of the open-gap type in the records which I have examined, and in fact, am familiar with the use of the open-gap type in but a few instances since 1910, these instances being in the case of the battleship division of the United States Fleet which joined the British Fleet in its North Sea operations." * * * "The ships of the American division were promptly equipped with this type of apparatus obtained from the British in order that their communication scheme would conform to that of the fleet which they had joined."

Regarding the sets which you installed on the war ships at the Norfolk Navy Yard, to which you have testified, who provided you with these sets for installation?

A. These transmitters were placed on the floor of the shop and turned over to me to be installed in each case. [fol. 1145] I have no way of determining whether these transmitters were in stock in the Norfolk Navy Yard, or if they had been shipped from some other point for installation at the Yard.

Q. 8. Please state whether or not you saw any inscription or indication that the sets which you installed were obtained from the British Government, or came from England?

* * * * *

A. There was no indication, as far as I know, whether these sets had been made or shipped from England.

Q. 9. Can you produce any diagrams relating to the 126 meter transmitting sets that you saw or installed at the Norfolk Navy Yard?

A. Yes, I produce two such diagrams (Reproduced Opposite).

Q. 10. Who made these diagrams, and when?

A. These diagrams were made by myself from the actual apparatus as I was working on this type of transmitter.

Q. 11. At about what time did you make these diagrams?

A. These diagrams were made about 1917 or 1918.

Q. 12. Please state the essential features of the apparatus indicated in these diagrams.

A. The essential feature was the use of a straight-gap enclosed in a wooden air-tight box, and which was provided with a powerful blower and electric motor; the primary inductance consisted of two upright angle copper rods, secured to each side of the gap box; these rods were provided with a cross rod which slipped over the right angle rods, so that the wave length could be adjusted at any point in the primary circuit. This primary circuit was then loosely connected by condensers to a coupling condenser board, which was also made up of small fixed condensers manufactured from mica and tinfoil; this condenser board also contained a variable condenser which was on the order of a pump, by which slight adjustments could be made to the antenna; the antenna loading coil consisted of a spiral tubing about twelve inches in diameter, from which the antenna-period could be adjusted. In the primary power transformer circuit, which consisted of a break-in relay so that signals could be simultaneously sent and received; this circuit also contained a motor generator starting resistances and switches for the adjustment of the primary power circuit.

Q. 13. At what input power were these transmitting sets rated?

A. The rating of these sets was 1 K. W. input.

Q. 14. Did you measure the antenna radiation from these sets and, if so, what did you find it to be?

A. The antenna radiation of the 126 meter set was about three-tenths of an ampere.

Q. 15. Will you please describe a little more fully the variable condenser which you have stated "was on the order of a pump"?

[fol. 1146] A. This condenser was made up of two pieces of brass tubing, one of which was insulated and was made to slide on the inside of the larger tubing, the inner tube being supported on insulated rods, with a handle on the front for the operation or degree of sliding.

Q. 16. Will you please point out and identify by any words you may find, the variable condenser you have just

referred to, as indicated in the diagrams which you have produced?

A. The variable condenser referred to in the diagrams has the wording "Coupler Located in Middle of Board".

Q. 17. Will you also please point out and refer to by any designation you may find, the primary inductance referred to in your answer to Q. 12?

A. The primary inductance on the diagram is referred to as "P. P."

Q. 18. What do the letters "C C" indicate in these diagrams?

A. The letters "C C" are used to designate two mica insulated condensers of a small capacity.

Q. 19. What was the order of the capacity of these condensers which you have referred to as having small capacity?

A. I cannot exactly tell the capacity of these condensers marked on the diagrams as "C C".

Q. 20. Will you please state the effect of the powerful blower and electric motor which you referred to in answer to your Q. 12?

A. This blower was used to cool the gap and to keep the spark steady.

Q. 21. In tuning these short-wave transmitters to the desired wave length, will you please state what you did as actual operations, referring to the parts of the diagrams, if you will, as indicating the adjustments that you made?

A. In tuning this transmitter to 126 meters we would first make adjustments at "P P" on the primary inductance, and then, by holding a standard wave meter within two or three feet at this point, we could determine if this part of the circuit would measure 126 meters; if not, these sliding pieces would be again adjusted until the desired wave length was found; then the antenna would be adjusted on the loading coil and the variable condenser or coupler on the coupling board would be adjusted to maximum radiation on the meter marked "H A" in the diagrams; the wave meter would then again be placed near the antenna and the set again checked for the wave length of 126 meters. The current during this operation being placed in the circuit by the pressing of the sending key, as shown in the circuit. After all adjustments were made, a record of the inches on the primary inductance would be placed on a tuning chart, also the inches of the coupler on the coupling

board and also the number of turns in the antenna loading coil, together with the amount of power used on the input and the amount of radiation in the antenna. These charts were then turned over to the Yard Radio Officer and a copy left on board the vessel.

Q. 22. When these sets were adjusted to a wave length of 126 meters did you find that they radiated waves of any other wave lengths at the same time?

A. My experience in adjusting these sets to 126 meters was that they admitted no harmonics or other wave lengths than the one desired, that being 126 meters.

Q. 23. Referring in the diagrams to the abbreviation "Trans." and to the letters "P" and "S", will you please state the construction of this transformer, as well as the voltage and the periodicity of the current applied thereto?

A. The words "Trans." as noted on the diagram, means [fol. 1147] "Transformer"; this transformer was the main power transformer for the complete set; this transformer consisted of a primary and secondary, which are designed on the diagram as "P" and "S". These coils were wound on a closed iron core and the input of primary voltage was rated at 100 volts, the secondary voltage was probably around 12,000 volts. This transformer was enclosed in a wooden box with terminals on the top for connections to the circuit.

Q. 24. Will you please describe a little more fully the parts indicated in these diagrams as "Horn Gap" and "Gap"?

A. The words "Horn Gap" were given this type of gap, due to the fact that all straight gaps resembled a horn. It has no particular bearing on this special gap.

Q. 25. What was the shape and material of the terminals constituting these gaps?

A. These gaps were made up of about three-eighths brass rod with a round copper ball screwed on one end of each rod, one of the rods was fastened by insulation to the inside of the box, while the other worked with an adjustable screw-handle, so that the distance between the gap balls could be adjusted.

Q. 26. On one of these diagrams I notice the words "For Yard Station". Why was this put on the diagram by you?

A. The words "For Yard Station" were used in the case where I had installed one of these sets at the Yard Radio Station, which was located in the Yard, for experimental

purposes. This set was intended to be used with the Fleet, while laying at anchor in Hampton Roads; this transmitter and circuit is the same as was installed on the war ships by me at the Navy Yard.

Q. 27. Did you operate this particular set?

A. I operated this set and checked it for wave length.

Q. 28. To what extent was set installed at the Norfolk Navy Yard, used for actual transmission to war ships at Hampton Roads?

A. I do not believe that this set was actually used for transmission to the Fleet, due to the fact that all these sets in the Navy Yard Station were remote-controlled from the Naval Base which was a distance of about seven miles; the antennas at the receiving station were so long that it was impossible to get down to this wave band. I made tests with this set by adjusting the wave length to around 300 meters, and it was heard very distinctly at the receiving station, and when the wave length was brought down below 200 meters, the signals were lost, this showing that the receiving station was not properly adjusted to receive this wave band.

Q. 29. Where was this transmitting station you have just mentioned, in relation to the Norfolk Navy Yard?

A. The transmitting station was in the Navy Yard and the receiving station was located in the Administration Building at the Naval Base, the reason being that when an operator was sending a message from the receiving station to a ship, he could hear his own signals while sending, as well as any other ship that wanted to call him at the same time he was operating one of the transmitters. This operation is called "remote-control."

Mr. Vaill: Counsel for claimant offers in evidence a photostatic copy of the two diagrams produced by the witness in answer to Q. 9, and requests that the same be marked "Claimant's Exhibit No. 207".

(Said exhibit marked as requested.)

[fol. 1148] Cross-examination.

By Mr. Edwards:

X Q. 30. Do the two drawings forming part of "Claimant's Exhibit No. 207" both represent the same type of set?

A. The two drawings both represent the same type of transmitter of the 126 meter type, with one exception: on one diagram marked "For Yard Station", the magnetic key has been left out, due to the fact as using it on remote-control this key was not necessary in this case.

X Q. 31. In what units of measurement was the scale of the measuring instrument "H A" in the antenna calibrated?

A. I don't remember those.

X Q. 32. I mean in amperes, or kilo-watts, or what?

A. In amperes, but I don't remember the scale of the meter.

X Q. 33. You mentioned in answer to Q. 14, that the antenna radiation was about three-tenths of an ampere; how much energy would that represent in watts?

A. To measure the antenna current in watts, would be a difficult matter for me to explain as the voltage at this point is so high and special instruments would have to be made to determine the voltage, whereby with the amperes the watts could be determined.

X Q. 34. Can you state what was the amount of energy radiated from the antenna?

A. I cannot state the amount of energy radiated from the antenna, only what was radiated in the antenna, which was three-tenths of an ampere.

X Q. 35. But can you not give an expression of how much energy that three-tenths of an ampere represented?

A. Do you mean in watts?

X Q. 36. Yes.

A. No, I have no way to determine.

X Q. 37. Well, you understand, do you not, that merely stating the amperage of a current is nothing more than stating in effect, quantity, without expressing the amount of energy?

A. The amount of energy leaving the antenna would be very hard for me to determine, due to the absorption of the radiated current, due to the guys and stays in the rigging.

X Q. 38. Well, you understand, do you not, that when you give only the amperage in the antenna, you are not even stating the energy in the antenna?

A. The three-tenths ampere radiation, to my knowledge, expresses the excitation of the antenna to that degree.

X Q. 39. Do you understand that it expresses the energy in the antenna?

A. I do.

X Q. 40. Do you understand that merely expressing measurement of a current in amperes is sufficient to express the energy of the current?

A. In some cases energy is expressed in watts and horsepower, but in this case where only one value is known, it is impossible for me to express further what energy or wattage is applied in this case to the antenna. Most transmitters of my experience are expressed by watts or kilowatts input, which is easily determined; considerable loss from this point is customary in a circuit of this type, or any other type of transmitter, due to heat and insulation.

X Q. 41. Will you please answer the preceding question?

(X Q. 40. repeated.)

A. As far as I know, yes.

X Q. 42. Do you not understand that the unit of measurement "watt" is a product of the voltage and amperage of a current?

A. I understand Ohms law quite well, and that the amperes multiplied by the voltage will determine the watts.

X Q. 43. In your answer to Q. 13 you stated the input [fol. 1149] power of these sets as being 1 k.w., that would mean 1,000 watts, would it not?

A. The input as determined by me as 1 k.w., would equal 1,000 watts power.

X Q. 44. Do you not recognize that when you give the input as 1,000 watts and only state the amperage in the antenna, that you are not giving any information as to the comparative input energy, and energy in the antenna?

A. As my tests and technical education extend to only a certain point, it would be impossible for me to determine the output in watts as applied to the 126 meter transformer.

X Q. 45. Can you state the voltage of the current in the antenna, or the resistance of the antenna?

A. The only measurements taken on these sets during calibration were the wave length and the antenna current. The resistance and capacity of the antenna were never placed on the records; in some cases the natural period of the antenna alone would be taken and placed on the record.

X Q. 46. Do you know the range of transmission of these sets?

A. I have never transmitted with this type of set to any given point so, therefore, have no way of determining the distance that these sets would transmit.

X Q. 47. In calibrating these sets, within what limits of accuracy would the wave lengths be adjusted?

A. The wave lengths of the 126 meter sets were adjusted as near as possible to 126 meters; in one or two cases it was impossible to adjust the set any lower than 130 meters, which, I judge, was due to an excess length of antenna. At any lower degree, in this particular case, the radiation would go to about one-tenth of an ampere, so in most cases my idea was to adjust the set as near 126 meters with a fair radiation at three-tenths of an ampere.

X Q. 48. How much of a departure from 126 meters did you permit as a maximum?

A. I would never calibrate a set to more than 130 meters; if the set would not calibrate at that wave length or shorter, I would generally take off a few feet of the antenna, where possible; in most cases these antennas were made up of a six inch cage type about fifty feet long, so it was impossible to shorten the antenna without practically reconstructing same.

Last question by the Notary: Do you know of any other matter relative to this claim?

A. I do not at the present time.

Deposition Closed

Deposition of Fred Hutton Kroger, for Claimant, taken at New York, N. Y., on the 26th day of October, A. D., 1926

Direct examination.

By Mr. Vaill:

Q. 9. Are you the same Fred H. Kroger who testified heretofore in this case on June 4th, 1926?

A. I am.

Q. 10. With what organization were you connected in the years 1917 and 1918?

A. With the International Radio Telegraph Company, located at 67 35th Street, Brooklyn, New York.

[fol. 1150] Q. 11. What was your position with the International Radio Telegraph Company during the years mentioned?

— Chief Engineer.

Q. 12. As Chief Engineer what did your work with the International Radio Telegraph Company include?

A. Design of spark transmitting equipment.

Q. 13. Did you design the spark transmitting equipment for any particular organization or customers of the company?

A. The Navy Department and the Army constituted the major customers to whom we supplied spark transmitting equipment during the years mentioned.

Q. 14. Can you give the particular designations by which transmitting sets made for the Navy and the Army of the United States were known at that time?

A. The major part of the spark transmitting equipment delivered to the United States Government during the time mentioned was known by the type numbers S.E.1300 and S.E.1310 for the Navy and S.C.R. 73 for the Army.

Q. 15. Please state whether or not actual orders were received by the International Radio Telegraph Company from the United States Navy and Army for these sets?

A. There were.

Q. 16. Can you give the approximate number of these sets ordered by both the Navy and the Army?

A. The Army placed an order for about 5,000 of the S.C.R.73 and the Navy an order for about 250 of the S.E.1300 and some 500 of the S.E.1310.

Q. 17. To what extent were these orders filled and delivered to the Government?

A. About 3,000 were delivered to the Army and about 200 to the Navy.

Q. 18. What was the reason that more of them were not delivered?

A. The undelivered portion was cancelled, due to the Armistice, terminating the World War.

Q. 19. What was the general nature of the spark-producing portion of these transmitting sets you have mentioned?

A. It consisted essentially of the high-tension transformer supplied by alternating current; this transformer charging a condenser which was discharged synchronously by a rotary spark-gap through an inductance set at a value to give the required wave length. The oscillating energy in this circuit is transferred to a tuned antenna connected conductively to the inductance referred to. In the application of this apparatus to air-craft the ground connection was the frame of the airplane and the antenna usually of the trailing wire type.

Q. 20. What proportion of the 5,000 S.C.R.73 sets ordered by the Army and the 750 sets ordered by the Navy of the S.E.1300 and the S.E.1310 types was intended for use on aircraft?

A. All of them.

Q. 21. Referring further to the structural characteristics of the spark transmitting sets manufactured for the U. S. Army and Navy, will you please state how the power was supplied for rotating the rotatable parts of the sets?

A. The power was obtained by means of a propeller driven by the force of the wind and which was connected directly to one end of the alternating current generator shaft which, in turn, was supplied with the rotary spark-gap on the other end.

Q. 22. Where was this propeller, the alternating current generator and the rotary spark-gap located with reference to the fuselage or body of the aircraft?

A. In the case of the Navy, it was located underneath the forward edge of one of the wings, this was also a location used by the Army, but in the case of the Army more often located on the struts of the landing gear.

Q. 23. What was the general shape and nature of the container in which the parts were carried as referred to in your last answer?

A. The assembly was so arranged as to permit the outline of the shell covering this assembly to be of streamline contour.

Q. 24. In answer to Q. 19 you mentioned a tuned antenna. Will you please state how the tuned antenna was adjusted to wave length and also the other parts of the circuit associated therewith?

A. The primary or spark circuit was set at the wave length assigned by a switch which could be adjusted to connect to that tap on the primary circuit inductance which

would give the desired wave length and then the inductance provided as an additional unit to the equipment was varied to give resonance with the primary circuit, as indicated by a maximum reading of the antenna ammeter.

Q. 25. What was the nature of the inductance provided as an additional unit in the equipment referred to?

A. It consisted of a helix of wire wound on a form having associated with it mechanism for varying the number of turns, consequently the inductance, used.

Q. 26. Where was this portion of the apparatus located with reference to the other parts you have mentioned?

A. This inductance was located near the operator accessible for conveniently adjusting the resonance.

Q. 27. With what person in the Navy Department did you have most to do concerning these transmitting sets of aircraft types S.E.1300 and S.E.1310, before mentioned by you?

A. With Mr. T. Johnson, Jr., Radio Aide.

Q. 28. In what way did you come in contact with him?

A. Mr. Johnson was assigned by the Navy Department as the party with whom all technical matters ~~were taken~~ up with reference to Naval aircraft transmitters and, therefore, all discussion of specifications and tests were made in conjunction with Mr. Johnson.

Q. 29. Do you know whether or not any descriptions have been published of these aircraft radio transmitting sets manufactured for the U. S. Navy, and if so, please state what they are.

A. Yes, in the Navy Manual for 1919 and 1924, under the chapter entitled "Aircraft."

Q. 30. I hand you copies of these Manuals and ask you to point out or name the pages of these Manuals on which these descriptions occur.

A. Referring to the 1919 Edition of the Navy Manual, a description of the S. E. 1310 type is found on pages 220 to 223, inclusive. Referring to the 1924 Edition of the Navy Manual, a description of the S.E.1300 will be found on pages 545 to 547, inclusive.

Q. 31. Please state to what extent these descriptions you have referred to in the 1919 and 1924 Navy Manuals describe and illustrate the Navy type S.E. 1310 transmitting sets.

A. The description of the S. E. 1300 referred to, applies ostensibly to the S.E.1310, except that in the latter case the

power rating was 500 watts, while in the case of the S.E.1300 it was 200 watts.

Q. 32. To what extent, if any, do these Navy S.E.1310 and S.E. 1300 sets differ from those furnished the U. S. Army as S.C.R.73?

A. The S.C.R.73 and S.E.1300 sets are the Army and Navy type numbers for the same apparatus. No apparatus of the S.E.1310 type was furnished to the Army.

[fol. 1152] Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of pages 215, 217, 220, 221, 222 and 223 of the Naval Manual for 1919, and requests that the same be marked "Claimant's Exhibit No. 208".

A photostat copy of pages 545, 546 and the illustration opposite page 546, designated as "Fig. 13", and requests that the same be marked "Claimant's Exhibit No. 209".

(The Notary marks said exhibits as requested.)

It is agreed between counsel that the publications referred to above as "Naval Manuals" are respectively entitled "Robison's Manual of Radio Telegraphy and Telephony for Use of Naval Electricians, 5th Edition, Annapolis, Md., United States Naval Institute 1919" and "Robison's Manual of Radio Telegraphy and Telephony for Use of Naval Radiomen, 6th Revised Edition, Annapolis, Md., The United States Naval Institute 1924".

Mr. Edwards: It is not to be implied that defendant's counsel admits that the publications were published by the Navy Department or other branch of the Government.

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Q. 33. To what extent did you see the aircraft transmitting sets designated as S.E.1300, S.E.1310 and S.C.R.73 in use upon aircraft operated, or to be operated, by the U. S. Army and Navy?

A. The only sets of the types referred to which I saw operated after installation were those which I personally tested in the Army and Navy airplanes.

Q. 34. Please state how many when and where, you personally tested and installed, of the sets inquired about on airplanes.

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A. One set of the S.C.R.73 type I tested in an airplane at Langley Field, and another of the same type I tested in

conjunction with an Army Officer at Mitchel Field. One of the S.C.1319 sets was tested by me in one of the HS hydroplanes of the Navy at Hampton Roads.

Q. 35. Will you please state where the Langley and Mitchel Fields were located at that time?

A. Langley Field was located near Old Point Comfort, Virginia, and Mitchel Field near Mineola, Long Island.

Q. 36. Will you please state about when these sets were tested by you, as stated in your last answers?

A. During the Spring and Summer of 1918.

Q. 37. To what extent are the circuit diagrams, the illustrations and the descriptions in "Claimant's Exhibits Nos. 208 and 209" correct, as regards the S.E.1300 Navy sets described by you in your answers to previous questions? ~

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A. The exhibits are correct.

Q. 38. I invite your attention to the following sentence taken from page 1137 of the Printed Record in this case, [fol. 1153] which comprises a portion of an answer to Q. 36 asked of defendant's witness E. H. Loftin, and will ask you to what extent, according to your knowledge, the statement made therein is correct, or incorrect:

"I have in recent years examined the records of purchases of radio apparatus of both the United States Army and the United States Navy since 1910, and while an extremely large number of sets were purchased since that date, particularly during the war, I do not recall a single instance of purchases of the open-gap type in the records which I have examined, and in fact, am familiar with the use of the open-gap type in but a few instances since 1910, these instances being in the case of the battleship division of the United States Fleet which joined the British Fleet in its North Sea operations."

A. The sentence quoted would appear to be incorrect, in view of the relatively large number of open-gap sets supplied by the International Radio Telegraph Company to the Navy and Army during the time the United States was involved in the World War.

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Mr. Edwards: No cross-examination.

Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

Deposition closed.

Deposition of T. Johnson, Jr., for Claimant, Taken at New York, N. Y., on the 27th day of October, A. D. 1926.

First Interrogatory by the Notary: State your name, your occupation, your age and your place of residence; whether you have any, and if any, what interest direct or indirect, in the claim which is the subject of inquiry; and whether, and in what degree, you are related to the Claimant.

Answer: My name is Theophilus Johnson, Jr.; my age is 34; my residence is 22 Hampton Avenue, Schenectady, New York; occupation, Commercial Engineer with the General Electric Company, at Schenectady, New York; I have no interest, direct or indirect in this claim, and I am not related in any way to the Claimant herein.

Direct examination.

By Mr. Vaill:

Q. 1. About how long have you occupied your present position as Commercial Engineer with the General Electric Company?

A. Since 1920.

Q. 2. What was your occupation prior to that time?

[fol. 1154] A. Expert Radio Aide Bureau of Steam Engineering, Navy Department, Washington, D. C.

Q. 3. When did you commence your work in that capacity?

A. 1917.

Q. 4. What were your main main duties as Expert Radio Aide in the Navy Department?

A. Supervision of the design of radio apparatus, including that for aircraft.

Q. 5. What other duties, if any, did you have relative to the operation of radio apparatus for aircraft?

A. Supervision of tests.

Q. 6. Where was such work carried out by you?

A. Norfolk, Va., and Anacostia, D. C.

Q. 7. After the design of radio apparatus for the aircraft of the Navy Department, by whom was such apparatus manufactured?

A. The International Radio Telegraph Company, Western Electric Company, Marconi Wireless Telegraph Company, Cutting & Washington, General Radio Company, General Electric Company.

Q. 8. What kind of sets were manufactured by the International Radio Telegraph Company?

A. Spark transmitters, known as types S.E.1300 and S.E.1310.

Q. 9. Will you describe briefly the S.E.1300 and S.E.1310 spark transmitting sets manufactured by the International Radio Telegraph Company, particularly as to the kind of spark-producing devices used in these sets?

A. A single description will serve for both types, which differed only in the power of the alternator and resulting power output in the antenna, the S.E.1300 having a rated alternator output of 200 watts and the S.E.1310 a rated output of 500 watts. Each equipment consisted of an alternating current generator which charged a condenser, this condenser being discharged by a synchronous spark-gap giving 1,000 sparks per second, into a primary inductance. This circuit was conductively coupled to an output or antenna circuit. The alternator and spark-gap were mounted on the same shaft and were furnished with motive power from an air-driven propeller. The primary oscillating circuit was tuned by taps on the inductance; the secondary circuit was tuned by a variometer. All units, with the exception of the variometer, were mounted in a streamline case, which was in turn usually mounted on an aircraft wing. The variometer with an antenna ammeter, was mounted in the body of the aircraft. A trailing-wire-type of antenna was used.

Q. 10. You have stated that the alternator and spark-gap were mounted on the same shaft. Will you please explain a little more in detail how this spark-gap was operated by the shaft referred to?

A. The spark-gap mounted on the alternator shaft was of the rotary type and consisted of fixed electrodes and rotating electrodes, so arranged that the condenser referred

to would discharge synchronously into the primary inductance.

Q. 11. In your answer to Q. 9 you stated that a synchronous spark gap giving 1,000 sparks per second discharged into a primary inductance. In speaking of the primary inductance, did you intend to refer to a transformer or to the antenna inductance?

A. The primary inductance formed part of an oscillation transformer, the secondary of which was in the antenna circuit.

Q. 12. How was the power transmitted from the generator to the spark gap and condenser you have mentioned?

[fol. 1155] A. The alternator was connected to the spark gap and condenser through a transformer, the purpose of which was to step-up the voltage of the alternator.

Q. 13. Where was this transformer located as regards the position of the generator and other parts you have mentioned?

A. This transformer was located in the streamline case previously referred to.

Q. 14. Please state to what extent you personally saw the S. E. 1300 and S. E. 1310 types of transmitting sets as installed on Navy aircraft?

A. I personally witnessed the tests made of this apparatus before its purchase by the Navy Department and personally engaged in the operation of this apparatus on aircraft during these tests. Approximately 250 type S. E. 1300 and 500 type S. E. 1310 sets were ordered by the Navy and I personally saw these in the process of manufacture at the factory of the International Radio Telegraph Company, and also personally saw them being installed on Navy aircraft for regular operating service.

Q. 15. With whom did you come in contact in connection with your visits and relations with the work of the International Radio Telegraph Company?

A. With Mr. F. H. Kroger, then Chief Engineer of that Company.

Q. 16. At what place were these transmitting sets S. E. 1300 and S. E. 1310 mainly installed on aircraft?

A. At the various Naval Air Stations in the United States,—at Chatham, Mass.; Cape May, N. J.; Norfolk, Va.; Anacostia, D. C. I personally saw these sets installed at these Air Stations; there was also several other Stations at which they were installed.

Q. 17. I invite your attention to a book entitled "Robinson's Manual of Radio Telegraphy and Telephony, 1919", of which certain pages, beginning with page 215, have been introduced in evidence in the form of photostat copies, as "Claimant's Exhibit No. 208", and also a book entitled "Robinson's Manual of Radio Telegraphy and Telephony, 1924", of which certain pages, beginning with page 545, have been introduced in evidence as "Claimant's Exhibit No. 209", and ask you what you recognize these pages to be.

A. I recognize pages 215 to 223, inclusive, of "Claimant's Exhibit No. 208" as describing the type S. E. 1300 and type S. E. 1310 sets referred to. I recognize pages 545, 546 and opposite Fig. 13 of "Claimant's Exhibit No. 209" as describing these sets.

Q. 18. From your knowledge of the S. E. 1300 and S. E. 1310 sets, will you please state whether or not the circuit diagrams shown in "Claimant's Exhibits Nos. 208 and 209" are correct representations of the electrical circuits used in these sets?

A. The diagrams shown in these exhibits are correct representations of the circuits used.

Q. 19. I invite your attention to Volume 8 of the Proceedings of the Institute of Radio Engineers for the Year 1920, particularly to pages 3 and 87 and the pages subsequent thereto, and ask you what you recognize these pages to be?

A. The article referred to is a paper presented by me before the Institute of Radio Engineers and entitled "Naval Aircraft Radio". On pages 32 to 38 is included a description of the types S. E. 1300 and S. E. 1310 sets.

Q. 20. In your last answer you have stated that the pages shown you constitute a paper presented by you; will you please state who composed or wrote this paper?

A. I personally wrote this paper which, before presentation was approved by the Navy Department.

[fol. 1156] Q. 21. Referring to page 33 of the Proceedings of the Institute of Radio Engineers mentioned in my previous question, will you please state whether or not Fig. 40 is a correct diagrammatical representation of the circuits in the types S. E. 1300 and 1310?

A. Fig. 40 referred to is a correct representation of the circuits used.

Q. 22. Can you state on what kinds of aircraft these two types of apparatus were installed?

A. On seaplanes known as types N-9 and R-6, and on flying boats known as types HS-1, HS-2, F-5-L and NC-4.

Q. 23. Which one of these flying boats you have mentioned is particularly noteworthy as to satisfactory performance of distance?

A. The NC-4, which made the Trans-Atlantic flight in 1919, from Rockaway, Long Island, to Lisbon, via the Azores, and Newfoundland. On this flight the set type S. E. 1310 on the NC-4, maintained perfect communication with the Cape Race Station up to a distance of 650 nautical miles. The signals from this S. E. 1310 were copied perfectly by the Naval Radio Station, Bar Harbor, Me., when the NC-4 was 1,400 miles distant.

Q. 24. Where was the Cape Race Station located with reference to the NC-4?

A. It was located approximately Northwest of the NC-4, on Newfoundland.

Q. 25. Referring again to your article in the Proceedings of the Institute of Radio Engineers, will you please point out where this NC-4 flight is referred to?

A. On pages 127 and 128.

Q. 26. From what source was the information of this flight and performance of the transmitting set on the NC-4 obtained by you?

A. From official Navy reports, which should be on file in the Navy Department, Washington, D. C.

Q. 27. In answer to Q. 20 you stated that approximately 250 of the type S. E. 1300 sets and 500 of the type S. E. 1310 sets were ordered by the Navy Department. How many of these sets were delivered to the Navy, if you know?

A. A total of approximately 300, the remainder being cancelled, due to the Armistice terminating the war.

Mr. Vail: Counsel for Claimant offers in evidence a photostat copy of pages 3, 32, 33, 34, 35, 36, 37, 38, 127 and 128 of the Volume of the Proceedings of the Institute of Radio Engineers, referred to by the witness, and requests that the same be marked "Claimant's Exhibit No. 210".

(The Notary marks said exhibit as requested.)

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Cross-examination.

By Mr. Edwards:

X Q. 28. What other types of radio transmitters for aircraft were designed by you or installed on aircraft under your supervision during the period you were with the Bureau of Steam Engineering?

A. Vacuum tube transmitters manufactured by the Marconi Wireless Telegraph Company, the General Electric Company and the General Radio Company, and a spark [fol. 1157] transmitter manufactured by Cutting & Washington.

X Q. 29. I note on page 32 of the Proceedings of the Institute of Radio Engineers, constituting a part of your paper entitled "Naval Aircraft Radio", the statement is made that:

"There are at the present time in use in the Naval aircraft service four types of standard spark radio transmitters."

Will you refer to that article and identify each of the four types referred to?

A. The four types referred to are the types S. E. 1300, S. E. 1310, both manufactured by the International Radio Telegraph Company, type S. E. 1320, manufactured by Cutting & Washington and a fourth type, ultimately little used, manufactured by E. J. Simon.

X Q. 30. Am I right in understanding that the circuit connections of the first two types, that is, the S. E. 1300 and S. E. 1310 are illustrated in Fig. 40, page 33 of the article, and that the circuit connections of the third type, the S. E. 1320, are illustrated in Fig. 44 of page 39 of the article?

A. Yes.

X Q. 31. What was the circuit arrangement of the fourth type?

A. This was a quenched-gap transmitter with inductively coupled oscillation transformer.

X Q. 32. Was the S. E. 1310 a plain gap, or a quenched-gap transmitter?

A. It was the synchronous rotary-gap transmitter.

X Q. 33. I note that in your paper to which we have been referring, the statement is made with respect to the type S. E. 1320, commencing on page 38,

"The transmitter is of the impact excitation type and is designed for transmission on a wave length of 375 meters only."

Does that accord with your recollection?

A. The type S. E. 1320 utilized a gap of the quenched type.

X Q. 34. How many types of vacuum tube transmitters were designed or installed under your supervision during this period?

A. Six.

X Q. 35. Did all of them employ approximately the same circuit as is illustrated in Fig. 56 on page 51 of your paper that we have been discussing?

A. No. Fig. 56 refers particularly to the types manufactured by the General Electric Company.

X Q. 36. None of the vacuum tube transmitters employed spark gaps of any kind, did they?

A. No.

X Q. 37. How did the number of transmitters of the various vacuum tube types compare with the number of spark-gap transmitters designed or installed under your supervision?

A. The number of spark transmitters actually installed on aircraft was of the same general order of quantity as the number of vacuum tube transmitters thus installed.

X Q. 38. What proportion of the spark transmitters installed were rotary-gap and what proportion quenched-gap?

A. Very approximately the same number of each type.

X Q. 39. I notice in Robison's Manual for 1919, on page 215, the statement is made:

"The earlier types of aircraft radio transmitters were mostly of the damped wave or spark type, having wind-driven generators as a source of primary current. The more modern transmitters are the valve type, using a generator directly connected to the aircraft engine, with a [fol. 1158] small capacity storage battery floating as an emergency source of power."

Does that accord with your recollection?

A. Yes, emphasizing that that statement refers only to the earlier types and the most modern types, and does not refer to the many intermediate types, of which the synchronous rotary-gap transmitter is one.

X Q. 40. On page 218 of the same publication, I note the statement:

"Figure 119 shows the fundamental airplane spark transmitter circuit. Either the quenched, rotary or impact type gap is used, preferably the latter."

Do you understand that this statement refers to the Figure 119 on page 217 of the publication, which latter page has been offered in evidence by claimant?

A. Yes.

X Q. 41. And is the statement in accord with your recollection?

A. Yes, except that I take exception to the statement "preferably the latter".

X Q. 42. Do you understand that the phrase "rotary or impact type gap" refers to one type or two types?

A. Two types.

X Q. 43. Will you state briefly the difference between the types?

A. Generally there is little essential difference between what is referred to as the "impact type gap" and the quenched type gap, as used with this general line of apparatus.

X Q. 44. What proportion of the spark transmitters installed during the period referred to were rotary-gap, quenched-gap and impact-gap respectively?

A. Approximately fifty per cent. rotary-gap, thirty per cent. impact type gap and twenty per cent. quenched-gap.

X Q. 45. I note that on page 218 of Robison's Manual, to which we have been referring, the statement is made:

"Fig. 119A shows the fundamental airplane valve transmitter circuit. The valve is the usual vacuum tube, with four terminals for the filament, plus and minus, the plate and the grid. The battery shown is for the purpose of keeping the filament hot."

Do you understand that that statement refers to Figure 119 A on page 217 of this publication, and if so, is the statement in accord with your recollection?

A. Yes.

X Q. 46. Are we to understand that it is your testimony that during the period from 1917 to 1920, while you were connected with the Bureau of Steam Engineering, that about half of the spark transmitters installed on Navy aircraft were rotary-gap transmitters?

A. Yes, as regards those installed and placed in operation.

X Q. 47. Are you acquainted with Mr. George H. Clark?

A. Yes.

X Q. 48. Was he connected with the Bureau of Steam Engineering during the period concerning which you have testified?

A. Yes, although leaving the Service of the Navy Department prior to the time that I did.

X Q. 49. Was he in the same Department or Unit that you were in?

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[fol. 1159] A. In the same Department, but his detailed duties differed from mine.

X Q. 50. Did you both report to the same authority?

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A. Yes.

X Q. 51. To whom?

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A. Commander S. C. Hooper.

X Q. 52. If Mr. Clark says that he was with the Department until June, 1919, would that be in accord with your recollection?

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A. Yes.

X Q. 53. Was he in position to have knowledge of radio set installed on Naval aircraft?

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A. Yes, although, after January 1st, 1918, my duties were specifically connected with aircraft installations and his were not.

X Q. 54. If Mr. Clark says that the quenched-gap sets formed the bulk of spark transmitters in the Navy between March, 1912, and ending in 1919, would that tend to change

your estimate as to the relative proportion of rotary and quenched-gap transmitters employed on aircraft during the period between 1917 and 1920?

A. No.

X Q. 55. Do you know of any reason why rotary-gaps were employed in the transmitters to which you have referred?

A. The manufacturers submitted the design and I do not know what particular reason they assigned to the use of the rotary-gap other than that they deemed it very suitable for the purpose.

Redirect examination.

By Mr. Vaill:

R. D. Q. 56. On cross-examination, X. Q. 42, you were asked concerning the rotary or impact type gap, and in answering X Q. 43, you referred to the "impact type gap, and the quenched-type gap". I will ask you to examine these questions and answers and to state what you understand to be the differences between the impact type gap and the rotary-type gap, as distinguished from the quenched-type gap?

A. The rotary-type gap consists of fixed and rotating electrodes, the arrangement of which and the speed of the rotating members determining the number of sparks per second. The quenched type gap and the gap used on the impact type transmitter, referred to in Robison's Manual, have fixed electrodes.

R. D. Q. 57. Did you mean to be understood by your answer to X Q. 43, that there is little essential difference between the rotary and the impact type gap?

A. I meant to indicate that in the mechanical arrangement and operation of the gap alone, the rotary type differed from the other two referred to.

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[fol. 1160] Last Question by the Notary: Do you know of any other matter relative to this claim?

A. No.

Deposition Closed.

Deposition of GEORGE H. CLARK, for Claimant, taken at New York, N. Y., on the 15th day of November, A. D. 1926.

* * * * * *

First Question by the Notary: State your name, your occupation, your age and your place of residence; whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry; and whether, and in what degree, you are related to the claimant.

Answer. My name is George H. Clark; my age is 45; my residence is 278 Madison Street, Passaic, New Jersey; occupation, Radio Engineer with the Radio Corporation of America; I have no interest direct or indirect in this claim, and I am not related in any way to the claimant herein.

Direct examination.

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By Mr. Vaill:

Q. 1. Are you the same George H. Clark who has previously testified on behalf of the complainant during its *prima facie* proofs in this case?

A. Yes.

Q. 2. On page 1034 of the printed testimony, defendant's witness Loftin, in referring to open-gap spark transmitters, states as follows:

"As to cooling of the electrodes, I have pointed out that heat is necessary for generating the metallic vapors which are beneficial for maintaining the gap active for a long time. In the use of these open gaps, the art has not resorted to cooling means, except where very large power is used, resulting in too rapid a consumption of the gap electrodes."

What is your knowledge concerning the use of cooling means, so far as it concerns your experience with Navy transmitters?

A. In the early days of the use of radio in the Navy, open gaps with artificial cooling means were very generally used. During the period from 1904 to about 1910, I saw many examples of these cooled gaps in use. The most conspicuous example was the gap used in the Slaby-Arco sets, many of which I saw in use in the Navy.

Q. 3. What was the size of these Slaby-Arco sets you have referred to, as concerns their capacity or power?

A. They were about 1 k. w. in power, or less.

Q. 4. What was the cooling means used in these sets?

A. The sets consisted of a cylinder in which condensed jars were placed and around which the inductance coil was wound. Above this cylinder was a smaller one containing the spark gap. Beneath the larger cylinder was placed a fan which drove air through several holes into the condenser chamber, and through holes in the top of this into the spark gap container, the air finally escaping through an orifice at the top of the spark gap holder.

[fol. 1161] Q. 5. I hand you "Defendant's Exhibit J-2" and will ask you if you find in this exhibit any illustration or other matter relating to the transmitting sets you have referred to in your previous answer.

A. I find on page 9 of this exhibit a drawing which is numbered "Fig. 13". This shows a cross-section of the Slaby-Arco transmitter I have described. I see here the fan, openings into the condenser or Leyden jar case, openings into the spark gap case, the spark gap itself, and an exhaust opening from the top of the spark gap case into the open air.

Q. 6. Can you name any other types of Navy transmitting sets that had their spark gaps cooled by artificial means?

A. Yes, several. One type which I saw in several Navy transmitting sets was known as the Sweet gap, developed by then Lieut. G. C. Sweet, U. S. N. This consisted of two hollow electrodes, facing each other, and with a rotatable plate between the opposing faces. This plate had various projections on it, on both sides, and of different thicknesses, so that the width of the two effective spark gaps on either side of it could be changed. The hollow electrodes were pierced with various holes, and air from a compressed air tank blew out through both sets of holes. This action cooled the gap, due to the expansion of the air from the small holes, and also tended to blow out the gap.

Q. 7. Do you recollect whether there are in the files of the Navy Department drawings of this Sweet air-cooled gap to which you have referred?

A. I know that such drawings were in the file of the New York Yard around 1910, but I have not seen them since.

Q. 8. Have you ever seen this Sweet transmitting gap in actual use, and if so, where?

A. I have seen it in use in several Naval vessels, of which I now recall the U. S. Steamship *Prairie* and the U. S. Steamship *Mississippi*. I also saw it in a Naval Shore Station in the South of the United States, which I think was St. Augustine.

Q. 9. What was the size or capacity of these transmitters using this gap?

A. About one or two k. w.

Q. 10. What other types of Navy transmitting apparatus had spark gaps cooled by artificial means within your experience in the Navy?

A. I saw and used other transmitters which had the Hogg spark gap, invented by Commander Hogg, U. S. N. This gap consisted, in the form that I saw, of a hollow tube opposing a solid plate, the axis of the tube being at right angles to the plane of the plate. The tube was one spark gap electrode and the plate the other. Air was blown into the lower end of the tube, and on emerging from the upper end, tended to blow out the spark and also cooled the gap. This type of gap was used in sets of from one to two k.w., and I recall that at least two Naval Shore Stations in the Southern part of the United States were using this gap in 1911.

Q. 11. Can you recall any other air-cooled spark gaps that were used during your connection with the U. S. Navy?

A. I remember that some early sets submitted by the DeForest Company had spark gaps cooled by an external blower, and I also recall operating sets installed by the Stone Telegraph and Telegraph Company on the U. S. Steamship *Georgia* and the U. S. Steamship *Minnesota*. I saw these latter sets in 1911. In the *Georgia* installation, the two spark gaps consisted of rings bearing half spheres around their opposing faces, and with air coming up through the hollow support of one ring, to cool the gap. In the second installation, the gap was a point-to-plate type, [fol. 1162] and air was blown from a nozzle at right angles to the line of the spark, thus cooling the gap.

Q. 12. During Defendant's answering proofs, Mr. Loftin has made several statements regarding quenched spark transmitters used in the Navy. Will you please state what experience you have had in operating and tuning Navy quenched gap transmitters?

A. I have tuned and operated many hundreds of sets of

this type, ranging in power from portable and submarine sets of a fraction of a kilo-watt, to sets of 10 k.w. capacity.

Q. 13. Will you please describe briefly the method you used in tuning such quenched spark transmitters?

A. In my answer, I will assume that the transmitter in question is of the inductively-coupled type, of which type almost all quenched gap sets consisted. The procedure in tuning up such a transmitter would be as follows:

(a) I placed the secondary coupling coil some distance away from the primary coil, at such a separation as experience had taught me would be much greater than the final coupling distance.

(b) I then adjusted the primary circuit to the wave length to which I desired to tune the transmitter, using for this purpose a wave meter very loosely coupled with the primary inductance.

(c) Next I adjusted the secondary or antenna circuit to resonance with the primary. The indication of resonance was the obtaining of maximum current in the antenna ammeter.

(d) I then increased the coupling by moving the secondary coupling coil closer to the primary coil, continuing this until I obtained the maximum antenna radiation that could be had, consistent with a small decrement of the emitted wave. During this operation the alternating current supply source was adjusted so that the voltage on the quenched spark gap was that giving a clear note.

(e) I next measured the wave length sent out by the transmitter, using for this purpose a wave meter very loosely coupled with the antenna circuit alone.

(f) If this wave length did not agree with the wave length to which I was tuning the set, the above procedure was carried out all over again, the primary wave length being changed to a new value which experience led me to believe would result in the desired wave length being sent out by the transmitter. This was done, if necessary, several times, until finally the wave length measured in the antenna circuit was that desired.

Q. 14. Can you refer to any printed publication containing instructions for use of Naval Radiomen as to tuning

quenched spark transmitters which corresponds to the method you have described?

A. Yes. I have here a copy of "Robison's Manual of Radio Telegraphy and Telephony for use of Naval Radiomen", 6th Revised Edition, 1924. On page 538, under the heading "Wave-length tuning", the following paragraphs are instructions corresponding in general to the method of tuning which I have just described:

"(a), (c), (g), (i), (j), (k), (l), (m)," and on page 539, paragraphs "(o) and (p)." On page 539, under the heading "Full-power adjustments and tuning" the following paragraphs likewise are instructions as above:

"(a), (b), (c), (d), (e)", and under "(f)" the first paragraphs, and the last paragraph on the page, continuing for the first five words on page 540.

[fol. 1163] Q. 15. Who are given as the authors of this Manual you have mentioned in your last answer?

A. The title page states that the book was written by "Commander (Now Admiral) S. S. Robison, U. S. Navy, Revised by Commander S. C. Hooper, U. S. Navy."

Q. 16. Will you please state to what extent, according to your knowledge and experience, this Navy Manual and earlier editions of the Navy Manuals, were used by, and served as instruction books to, Radio operators and Radiomen generally in the United States Navy?

A. The editions preceding the volume which I have referred to in my answer to Q. 14, I have seen in practically every Naval Ship and Shore Radio Station that I have tested or visited. It was considered the standard Manual for instruction, and I often used it myself in giving instructions to the personnel of various Stations. The last edition, referred to in my answer to Q. 14, was issued after I left the Naval service, but since it is a continuing edition of preceding issues, I believe that it is likewise used as an authority for the instruction of Naval Radiomen.

Q. 17. Please state to what extent, according to your knowledge, these Naval Manuals relating to Radio Telegraphy and Telephony are regarded as standard reference books, and to what extent they are open to public inspection and purchase, if desired?

A. These Navy Manuals are considered by Radio Engineers generally as standard and authoritative reference books as to the state of the Radio art in the United States Navy. These Manuals have always been open to public

purchase and hence could be inspected by any purchaser or any other person viewing said book. These Manuals are on file in practically every Public Library.

Q. 18. On pages 1097 and 1098 of the Printed Record defendant's witness Loftin testified as follows:

"I will point out in connection with my discussion of the operation of the Seibt and Wireless Apparatus Co. type that there is no such thing as 'resonance' between the primary and secondary circuits of the quenched gap type."

In view of your experience with Navy quenched spark transmitters, will you please state the facts as you have found them, regarding resonance between the primary and secondary circuits of such transmitters?

A. I have always found that when such transmitters are in an operative condition, there is resonance between the primary and secondary circuits.

Q. 19. Will you please state what you may have in mind as embracing the term "resonance" used in your last answer?

A. I mean that if the wave length in the primary circuit and in the secondary circuit of an operative quenched gap transmitter be measured by a wave meter respectively coupled to each of these circuits alone, these measured wave lengths would be the same or substantially the same. By "operative condition" I mean that the transmitter shall have been correctly adjusted as to wave length and coupling.

Q. 20. How are the effects of tuning a quenched spark transmitter, as regards resonance and coupling and other characteristics of such circuits illustrated?

A. By means of resonance curves.

Q. 21. Can you produce any publication intended for use by Naval Radiomen that is in accordance with your testimony [fol. 1164] many concerning resonance between the primary and secondary circuits of a quenched spark transmitter?

A. In my answer to Q. 14 I referred to a book which I will henceforth designate as "Robison's Manual". In the 1911 issue of this Manual, I find on page 156 a set of curves showing the resonance curves in both the primary and secondary circuits of a quenched gap transmitter. That it is the latter type of transmitter is shown by the schematic diagram on the same page, where the spark gap in the primary circuit is marked "Quenched Gap". The wave length

at the resonant position in the primary circuit is 977 meters, and the wave length at the resonant position in the secondary circuit is 973 meters, which two values are substantially in agreement. I find the same curves and schematic diagram on page 179 of the 1913 edition of Robison's Manual (Reproduced Opposite), on page 180 of the 1915 edition and on page 203 of the 1918 edition.

Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of page 179 of Robison's Navy Manual of Wireless Telegraphy, 1913 Edition, and requests that the same be marked "Claimant's Exhibit No. 211".

(Said exhibit marked as requested.)

Q. 22. According to your experience with quenched spark transmitters, what has been the effect upon the apparatus when the primary and secondary circuits were not in resonance?

A. The antenna current radiated would be much less than when the two circuits were in resonance. The emitted wave would have two pronounced maxima or "humps". The gap note would be very poor, and the quenched gap itself would tend to "head" or form metallic short circuits between the plate, and would also become very hot.

Q. 23. Can you refer to any publication for use of Naval Radiomen containing statements in accordance with your testimony as given in your last answer?

A. Yes. In Robison's Manual, 1924 Edition, the following appears on page 528:

"The momentary current flowing in the primary circuit is very heavy and, if the antenna circuit is not coupled and in tune with it, there is a serious danger that the spark gap will be burned".

Also, on page 539 of the same Manual, at the bottom of the page, occurs the following:

"In no case should the antenna circuit be detuned (thrown out of resonance with the primary), because (a) there will be a reaction between the two circuits and two waves will be radiated which can be found on a wave meter coupled to the antenna circuit; (b) the gap will not quench properly, thereby heating, and power will be retransferred from the antenna to the primary, and back again to the antenna, and

the decrement will be increased due to this retransfer of power."

Q. 24. Please consider the following testimony of defendant's witness Loftin, beginning near the top of page 1105 of the Printed Record, and state any facts in accordance with your knowledge and experience that may have a bearing on the same, to-wit:

"In such a calibration, the operator will first carefully adjust the primary circuit to a definite frequency, using a wave meter which is an instrument for measuring frequency, being certain that the secondary or antenna circuit is open so as not to influence his measurement. He will then open the primary and adjust the secondary to the same frequency. Having so adjusted the two circuits, he then starts his set in operation, and listening to the note given off by the transmitter, will gradually throw the two circuits out of tune until a nice clear note is had, * * *."

A. I have never used the above-quoted method of adjusting a set to resonance. The method which I always employed, and which was the general method used by Radio Engineers and operators during the period that I was in the Naval employ, was as outlined in my answer to Q. 13.

Referring to the adjustments as outlined in the above text, the two circuits having been adjusted as described, and having further been coupled to the optimum coupling position (which is omitted from the text), the operator then proceeds to obtain a clear note. This is not done by gradually throwing the two circuits out of tune; on the other hand, the two circuits are left at the tuning position obtained when optimum coupling was determined. What the operator does do to obtain a clear note is to adjust the generator voltage for the number of gaps in use at the moment. If the voltage is too high, the note is hissing and not musical; if the voltage is too low, the note "breaks" and is ragged; at the correct voltage the note is a clear musical one, with the characteristic 500-cycle sound.

All other adjustments of the transmitter having been made, it is impossible to obtain a clear note except by generator voltage adjustment.

Q. 25. Can you refer to any publication intended for use of Radiomen that is in accordance with your experience as

to the adjustment of the alternating current generator voltage to get the desired clear sound or note suitable for transmission in a quenched spark transmitter?

A. Yes. In Robison's Manual, 1924 Edition, I find on page 539, under the heading "Full-power adjustments and tuning", instructions practically identical with the practice given by me in my preceding answer. On this page I refer to sub-paragraphs "(a), (b), (d), (e)," and under "(f)" the sentence "Adjustment to proper voltage for clear note is best made while sending letters".

Q. 26. Testimony has been given in this case on behalf of defendant by Mr. Loftin, found on page 1137 of the Printed Record, to the effect that the open-type spark gap transmitter in the Navy was replaced by the quenched gap type. Please state what your knowledge is on this matter.

A. About 1910, open-type spark gaps began to be replaced in the Navy by quenched gaps. By 1916 or thereabouts, almost all the sets were fitted with quenched gaps, with the exception of some Shore Stations and a number of vessels still using rotary synchronous gaps. Possibly there were twenty vessels using this latter type, most of these being torpedo boat destroyers.

Q. 27. Do you know whether these Navy ships on which the quenched gap transmitters had been placed, were provided with other types of gaps at the same time?

A. Yes. Practically every ship or Shore Station set having a quenched gap was fitted with an auxiliary gap of the non-synchronous rotating type. This was required by Navy specifications for spark gap transmitters.

Q. 28. What documentary Naval papers can you refer to, if any, that tend to confirm the statement of your last answer as to the non-synchronous gaps used on Navy ships?

A. I recall that the Naval specifications calling for the use of non-synchronous gaps were numbered RE 13-A 111.

In the 5th Edition of these specifications, numbered "RE 13A 111E", dated April 20, 1918, and headed "Specifications for" 1-2.5 & 10 K.W. Radio Transmitters", paragraph U, headed "List of Parts Comprising a Set" has, on page 25, the requirement that one quenched gap and one rotary non-synchronous gap are to be supplied with two k.w. sets, whether for d.c. or a.c. supply or engine-driven, and whether Navy standard or Naval auxiliary types of sets. The same requirement is found on page 39,

for five k.w. sets of the different classes above given, and the same is true on page 43 for ten k.w. sets. It is to be noted that only in the case of the one k.w. sets, on page 31, is the rotary non-synchronous gap not required in addition to the quenched gap.

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Q. 29. According to your knowledge and understanding, will you please state whether or not the original or copies of the specifications numbered "RE 13-A 111E", dated April 20, 1918, is on file among the records of the Navy Department?

A. The original typed copy, and the Van Dyke thereof, are on file in the Bureau of Engineering, Navy Department, Washington.

Q. 30. Understanding that you have at hand available for examination, a copy of these specifications referred to in the last question, will you please indicate therein the portions which refer to the rotary non-synchronous spark gap mentioned in your answer to Q. 28?

A. Beginning on page 115, and continuing on pages 116, 117 and 117 $\frac{1}{2}$, I find a paragraph which is numbered 38 and which is headed "Rotary, Non-synchronous, 500 Cycle, Spark Gap". A portion of these specifications, giving a general outline of the requirements for this gap is found in the following sub-paragraphs:

"(a). To be operated in place of the quenched spark gap in a radio transmitter which is supplied with power from a 500 cycle alternator.

"(b) The gap shall operate satisfactorily at any input between $\frac{1}{4}$ K. W. and 5 K. W.

"(c) Design must be such that a musical note, corresponding to 1,000 sparks, or 1,000 groups of sparks, per second, may be readily produced and maintained at any input between $\frac{1}{4}$ K. W. and 5 K. W. The dominant note of the spark shall correspond closely to that produced by an approved type of quenched spark gap transmitter. It shall also be possible to obtain and maintain a note corresponding to 125, 250, and 500 sparks, or groups of sparks, [fol. 1167] per second, with corresponding variation in power, by suitable variation in voltage or spark length, and while the spark is *on*."

"(h) The gap shall operate satisfactorily while sending continuously for five (5) hours. Satisfactory operation means that the proper spark note and the power input shall remain constant without necessity for adjustment during the test, which shall be made at any wave-length between 200 and 3,000 meters, inclusive."

There are many other sub-paragraphs in the paragraph giving specifications for this type of gap, which I will not quote here.

Q. 30. Will you please state, if you know, where the design of the rotary spark gap apparatus referred to in connection with these specifications, originated?

A. Designs prepared by commercial companies were accepted if approved by the Navy, but the majority of the rotary non-synchronous gaps used in Navy sets were built from Navy design. I think that in time the Navy design was finally made obligatory for all contractors.

Q. 31. Will you please state approximately, if you know, the date that the rotary, non-synchronous gaps designed by the Navy and such as referred to in the specifications, were designed?

A. I estimate that it was about 1914 or '15.

Q. 32. I will ask you to refer again to Navy specifications "RE 13 A 111E" and to refer to any matter therein which indicates that the previous specifications were changed in accordance with drawings furnished by the Navy.

A. I find on sheet 4, under the heading "Note 2. Specifications RE 13 A 111D differ from the preceding issue (RE 13 A 111C) in the following major changes:— "the following reference under paragraph 3, sub-paragraph g:

"Paragraph 28. Rotary Non-Synchronous Gap. Specifications changed. The Bureau will furnish drawings of a type of gap which will be acceptable".

However, the heading given above as immediately following "Note 2." is in error. The correct heading is that given on the following page numbered 5, which latter heading is a repetition of the heading which should have been placed on sheet 4. The matter on sheet 5 follows consecutively, as to paragraph and sub-paragraph numbers, to the matter on sheet 4. This correct heading which I have above stated, appears on sheet 5, and which should have appeared on sheet 4, is as follows:

"Specifications RE 13-A 111E differ from the preceding issue (RE 13-A 111D) in the following major changes".

Q. Please state, if you know, the source of the design of the particular rotary gap referred to in the specifications, as mentioned in your last answer.

A. The design was made at the Philadelphia Navy Yard. I saw some of the design being drawn up, and later saw gaps being manufactured at that yard in accordance with this design.

Q. 34. About what year was it that you saw these gaps?

A. About 1916.

Q. 35. What personal connection have you had, if any, with the specifications RE 13A- 111E, referred to by you in your previous answers?

A. I prepared these specifications.

Q. 36. Will you please state whether or not you had occasion to see any of these non-synchronous rotary gap transmitter sets in place for use on United States Navy vessels?

A. Yes. I tuned up a large number of transmitters in which this gap was furnished, along with the quenched gap, and personally used the rotary non-synchronous gap in such tuning. I have also observed these gaps in operation for the sending of messages.

The above operations, such as tuning up the sets and seeing them in actual service, took place on almost all the Battleships of the Atlantic Fleet, such as the Wyoming, Florida, Utah, and others. The same took place at a number of Naval Shore Stations on the Atlantic Coast, and on smaller vessels of the Service.

Q. 37. During what period was this tuning and observation, referred to in your last answer?

A. During the period of the first installation of the wave changer, in 1914, and continuing through 1916.

Q. 38. According to your observation and experience, what was the occasion for using the non-synchronous rotary spark gap during the instances you have mentioned?

A. This gap was used to replace the quenched spark gap when the latter might be broken down or might be under repair or cleaning. During such conditions, the regular radio work of the ship, or Shore Station would be carried on by using the rotary non-synchronous gap.

Q. 39. Can you refer to a printed publication where the Navy rotary, non-synchronous gap is described?

A. Yes. In Robison's Manual, 1924 Edition, the above gap is described on page 534 (Reproduced Opposite), and in Fig. 7 on that page is shown a picture of this gap. The picture is of the standard Navy design.

Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of page 534 of Robison's Manual of Radio Telegraph and Telephony, referred to by the witness, and requests that the same be marked "Claimant's Exhibit No. 212".

(Said exhibit marked as requested.)

Q. 40. Defendant's witness Loftin, in speaking of Navy wave changers, testified in answer to Q. 32, as recorded on page 1121 of the Printed Record, as follows:

"The mere fact that these wave changers included arrangements for adjusting the inductance of the two circuits in which the device was connected does not mean that the adjustment was for the purpose of securing resonance between the two circuits as contended by Mr. Waterman, for in the quenched gap type, resonance between the two circuits is not used, and the adjustments are for an entirely different purpose".

Will you please state, in accordance with your knowledge and experience, any facts that may have a bearing on this statement of Mr. Loftin regarding Navy quenched spark transmitters and wave changers?

A. The statement is incorrect. The adjustment or tuning of the two circuits in which the wave changer was connected was for the purpose of securing resonance between the two circuits, it being understood that I am referring to transmitters using the quenched gap. When the set is in operative condition, the two circuits must be in resonance, or substantially so. I have testified to this status in a previous reply and have shown recorded evidence thereof.

Q. 41. Will you kindly point out what you intend to include in the term "recorded evidence" referred to in your last answer?

A. I refer to the resonance curves on page 156 of Robison's Manual, 1911 issue, as referred to in my answer to Q. 21.

These resonance curves form "Claimant's Exhibit No. 211."

Q. 42. Upon what personal experience is your knowledge of the Navy wave changers and quenched spark transmitters based?

A. I have superintended the installation of, and have tuned and operated, hundreds of quenched gap transmitters in which the wave changer was a part of the mechanism. In co-operation with another radio engineer then in the service of the Navy Department, I invented the wave changer and by permission of the Navy Department, obtained a patent on the same from the U. S. Patent Office. I was assigned from Washington to the New York Yard to work with the radio engineer above-mentioned in designing and manufacturing the first Navy wave changer, and assisted in the design of succeeding types.

Q. 43. At the end of page 1124 and the beginning of page 1125 of the Printed Record, defendant's witness Loftin, in answer to Q. 34, testified as follows:

"Answer. The 'wave changers' referred to by plaintiff's witness Clark, were developed and designed for practical use after the quenched-gap type of transmitter was adopted by the Navy as a preferred form, and therefore included in the design particular consideration for the conditions to be met in quenched-gap operation, particularly in the matter of obtaining tight coupling".

From your knowledge and experience with these wave changers, will you please state the facts as regard the degree of coupling used therein?

A. The design of the Navy wave changer was such that loose coupling could be obtained as well as tight coupling.

Q. 44. On page 1125 of the Printed Record, Mr. Loftin also testified for defendant as follows:

"It was not possible, however, to use these wave changers with the open-gap type of transmitter, though I have never known one to be so used."

Will you please state the facts, in accordance with your experience, regarding this statement of Mr. Loftin?

A. It was possible to use the wave changers with the open gap type of transmitter. Practically every installation of the wave changer that I tuned and adjusted included

both a quenched gap and a non-synchronous rotary gap, and my adjustments were made first with the one gap, and then with the other. The non-synchronous rotary gap is an open type gap.

Navy specifications RE 13-A 111E, referred to first in my answer to Q. 28, contain on pages 35, 36, 37, 38, 39, 40, 41, 42, 43 and 44, the list of parts required for radio transmitters of 2 K.W., 5 K.W. and 10 K.W. capacity. In each case, there is required a quenched gap, a rotary non-synchronous gap, and a wave changer and inductive coupling. For instance, on pages 35 and 36, these items are respectively numbered 36, 37 and 43, this covering the 2 K.W. set. These required items show that the wave changer could be operated with an open-type gap, and my personal experience with Naval installations confirms this.

Q. 45. In what respects, if any, did the tuning and operation of the wave changers when used with the quenched gap, [fel. 1170] differ from the tuning and operation of the wave changers when used with a non-synchronous rotary gap?

A. As to adjustment of the closed and open circuit, there was no difference caused by which type of gap was used. The two circuits were substantially in resonance when correctly tuned for the rotary gap, just as they were when correctly tuned for the quenched gap. The coupling in the case of open gap operation was not critical, as it was with the quenched gap, and in general the operating coupling was looser in the case of the rotary than with the quenched gap.

Q. 46. How did the wave lengths of the primary or generating circuit compare with the wave lengths in the secondary or antenna circuit, when the quenched gap and the rotary gap portions were used respectively?

A. In either case the wave length of the primary circuit was the same as the wave length in the antenna circuit, or substantially so, when the set was correctly tuned for operation.

Q. 47. Referring again to the answer to Q. 34 of defendant's witness Loftin, as found on page 1125 of the Printed Record, will you please state whether the following testimony given by Mr. Loftin is correct or accurate, in view of your experience with wave changing devices, to-wit:

"The dials are marked with these predetermined wave lengths, and in setting up the apparatus for use when it is a quenched-gap type it is compulsory that the antenna or

open circuit be adjusted to the dial marking irrespective of any other adjustments of the apparatus."

A. I consider that this statement is very inaccurate and misleading. It is not compulsory that the antenna circuit be adjusted to the wave length of the dial marking irrespective of any other adjustments of the apparatus. It is just as compulsory that the closed circuit be adjusted to this same wave length. If both closed and open circuits are not substantially in tune with each other and with the wave length of the dial marking, the set is not in operative condition to transmit at that wave length.

When the wave changer handle is moved so that a definite wave length is indicated by the dial markings, this means (if the set is in operative condition), that the primary condenser is of the correct value for the wave length in question, that the primary inductance value is such that the primary circuit is in tune with the wave length in question, that the antenna series condenser is, or is not, in circuit with the antenna as determined by the requirements of the chosen wave length, and that the secondary inductance value is such that the secondary circuit is in tune with the wave length indicated on the dial markings. All these are compulsory if the set is adjusted for operative conditions.

Q. 48. Please state in what manner the dial markings were used on the Navy type of quenched spark transmitter employing the wave changing device?

A. The dial markings were placed opposite the contacts of the primary circuit, on the front of the wave changer, where also was located the handle for moving simultaneously the various arms of the device. Thus the operator in moving the handle would have, within easy vision, the markings which indicated the wave length he sought. In some cases, the wave length or dial marking was repeated on the rear panel of the wave changer, opposite the secondary contacts. I do not recall any Navy wave changer design where the markings were on the secondary only.

[fol. 1171] Q. 49. Can you refer to any printed publication that is in accordance with your last answer as regards the position of the wave length markers on the wave changers?

A. I find this on page 529 of Robison's Manual 1924 Edition (Reproduced Opposite). On this page is a half-tone of a photograph, marked "Fig. 2. 5-Kw, 500-Cycle,

Quenched-spark Transmitter. Front View". I identify herein the wave changer, which is a Navy design, and of which the front panel, with the wave length handle and the primary contact-arm is seen. Opposite the eleven primary contacts may be seen markers or tabs, and this is in accordance with my recollection of how the wave length markings were placed on the Navy wave changers which I used. These markers were engraved with the respective wave lengths in the range of the set.

Q. 50. According to your experience or observation outside of matters concerning the Navy Department, do you know whether or not these so-called wave changers have been used for commercial or other purposes, and if so, please refer to any publication which may describe or illustrate such wave changers?

A. The wave changers have been used for commercial purposes by commercial radio companies, particularly the Marconi Company of America. I find a description of a transmitter embodying this wave changer, and manufactured by the Marconi Wireless Telegraph Company of America, in an article written by Roy A. Weagant and published in Volume I, Part 4 of the Proceedings of the Institute of Radio Engineers, dated December, 1913. On page 47 of this article, I find the following:

"The transmitter here shown is designed so that eight definite and predetermined wave lengths * * * may be instantly obtained by the setting of a single rotary switch E, which makes connections in both open and closed circuits."

On page 49 of the same article (Reproduced Opposite) I find the following:

"The calibration of the primary circuit is accomplished at the factory. The fixed wave lengths used in these sets are 625, 750, 875, 1,000, 1,300, 1,575, 1,800, and 2,000 meters".

On page 50 of the same article, is found a front, side, and rear view of the transmitter. The front view shows the wave changer handle, and a pointer connected to it and passing over wave length stampings on a semi-circular dial.

None of the wave changer contacts are seen in this front view. The rear view of the transmitter shows the antenna

contacts and I see no indication of wave length markings on this panel. The foregoing description agrees with my recollection of this transmitter which I saw at the Aldene Works of the company.

Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of page 529 of Robison's Manual, referred to by the witness, and requests that the same be marked "Claimant's Exhibit No. 213".

(Said exhibit marked as requested.)

Mr. Vaill: Counsel for claimant also offers in evidence a photostat copy of page 49 of the Proceedings of the Institute of Radio Engineers, Volume I, Part 4, and requests that the same be marked "Claimant's Exhibit No. 214".

(Said exhibit marked as requested.)

[fol. 1172] Q. 51. How were the wave lengths indicated on Navy quenched spark transmitters that were not equipped with the wave changing apparatus?

A. In some cases by wave length markings placed directly on the clips used for the pick-off points in both the closed and open circuits. In some Telefunken sets, for example, the clips were provided with sockets at their outer ends, into which a plug could be inserted. Around this socket was a circular disk and on this disk was marked the wave length corresponding to the location of the clip on the coil.

Q. 52. Will you please describe the type of coils used in the Telefunken sets referred to in your answer?

A. These were flat spiral coils.

Q. 53. Will you please examine the illustrations forming part of "Claimant's Exhibit No. 206" and state what these illustrate, according to your knowledge of transmitting sets?

A. The first illustration is that of a Telefunken commercial type transmitter which is practically the same as the one to which I referred in my answer to Q. 51. The coils of the set are the same as the type I referred to in my answer to Q. 52. The second illustration is that of a Telefunken receiver, of the upright type, with primary and secondary tuning condensers.

Q. 54. Will you kindly also state what the other sheets of this "Exhibit No. 206" contain?

A. The first sheet refers to the leads to be run between the power source and the transmitter; this sheet is marked 167A. The second sheet is numbered 167 and contains schematic circuit diagram of the power board, the radio transmitter and the receiver. This sheet also contains instructions for tuning the set to a definite wave length, and for obtaining a clear spark. Both of these sets of instructions agree in general with the methods for tuning and for obtaining a good spark gap note, as described by me in my answers to preceding questions. The next sheet, number 162A, gives the wiring of the receiver, and also shows in schematic form diagrams illustrating how the receiver can be used with or without secondary tuning condensers. The next sheet, No. 152, shows the make-up of the primary inductance, and also shows the tuning positions for various wave lengths. These tuning positions are indicated on the drawing by small circles placed at various points on the spiral coil, these circles each bearing a number. In an attached calibration table the wave length which is obtained when the connecting plug is placed on the coil at any given numbered circle, can be read. The remaining two sheets are the illustrations to which I referred in my answer to Q. 53.

Q. 55. Continuing his answer to Q. 34, on page 1125 of the Printed Record, Mr. Loftin testified for defendant concerning the dial markings on the open gap type of transmitter as follows, the same coming immediately after the quotation forming a part of Q. 44 of your present deposition:

"If so used, the wave-length marking on the dial would determine the natural frequency of the primary circuit, as in the open-gap type the primary circuit has the duty of establishing the frequency of the entire system. That is, if the open-gap type, assigned predetermined frequencies [fol. 1173] marked on the dials of the wave changers, it would be compulsory to adjust the frequency of the primary circuit to correspond to the markings irrespective of other adjustments."

Please state with your experience with this type of set any facts that may have a bearing on the correctness of the testimony quoted.

A. I consider the above statement very incorrect and misleading. It is not compulsory to adjust the frequency

of the primary circuit, in a transmitter of the open gap type, to correspond to the wave length marking on the wave changer, irrespective of other adjustments. It is just as compulsory to adjust the frequency of the secondary circuit to this wave length marking. Unless both circuits are substantially tuned to the same wave length, such as the wave length of the dial marking, the set is not operative for use.

In an operative, correctly tuned, transmitter of the open gap type, using a wave changer, placing the handle of this wave changer to a position corresponding to a certain definite dial marking, means that the primary capacity has thereby been placed at the correct value for this wave length, the primary inductance system has been tapped off at the correct point so that the primary circuit is tuned to said wave length, the antenna series condenser is or is not in circuit as required by the wave length used, and the secondary inductance system has been tapped off at the correct point, so that the secondary circuit is tuned to the wave length of the dial marking. All these operations are compulsory if the set is to be in operative condition.

Q. 56. Referring to your last answer, where you mention the "antenna series condenser is or is not in circuit as required by the wave length used", will you please state how this antenna condenser was controlled in the wave changer?

A. It was usually inserted in series with the tap-off point of the secondary circuit for the wave length in question. That is, the lead from the secondary contact would pass through the antenna series condenser before going to the pick-off point on the secondary coil system. Thus, when the wave changer was moved to such a secondary contact the antenna series condenser would be automatically cut into circuit.

Q. 57. On what wave lengths did this antenna series condenser become necessary?

A. At short wave lengths, nearing the fundamental wave length of the antenna in use.

Q. 58. Testimony has been given in this suit by defendant's witness Loftin, recorded on page 1137 of the Printed Record, concerning the open gap transmitting sets on the U. S. Battleships connected with the British Grand Fleet in the North Sea during the World War. Will you please state what knowledge you may have of the use by the United States Navy of such sets under those conditions?

A. Early in 1918 I was detailed by the Bureau of Engineering, Navy Department, to proceed to Halifax, Nova Scotia, and observe the various component parts of the radio installation of a British Battleship. I went through the entire installation of H. M. S. Roxburgh, and noted the details of the transmitters and receivers, so that I would [fol. 1174] be able to do my part in arranging for the manufacture of similar or modified apparatus to be used in the United States vessels serving in Foreign Waters. Among other things I studied what the British called their "Type 9" or 126 meter set, which later was manufactured in this country practically in the same shape as the original installation I saw. It was called in our Navy, the "Inter-Fleet Set".

I also saw this set in operation, and noted its tuning, as Major Cheesman, British Liaison Officer to the U. S. Navy Department was present on H. M. S. Roxburgh and tuned the set up in my presence. This set was a two-circuit, condenser-coupled transmitter, with an open type spark gap, and with a blower to cool the gap. The tuning that I observed was very sharp.

On my return to Washington I had a little to do with the details of getting such a set in manufacture for our use, and later used the set after its installation on some of the U. S. Naval vessels.

Q. 59. What U. S. Naval vessels had such sets or similar sets installed on them, as mentioned in your last answer?

A. I recall an installation of this Inter-Fleet set on the U. S. S. Delaware, which set I adjusted in the Summer of 1918, and used for receiving experiments made on the U. S. S. Mississippi at that time. The latter ship also had a set of this type. From my knowledge of the engineering work done in the Bureau of Engineering, with which I was in constant touch, I know that these sets were installed on a large number of United States battleships.

Q. 60. What experience, if any, have you had on United States Naval vessels under sailing or cruising conditions, where the 126 meter transmitting sets were used?

A. I used this set during a cruise of the U. S. S. Idaho to Guantanamo in 1919, the ship sailing from New York.

Q. 61. Will you please examine "Claimant's Exhibit No. 207" and state what you understand this exhibit shows.

A. The two wiring diagrams shown in this exhibit are correct diagrams of the circuits of the Inter-Fleet or 126 meter transmitter, as I recall it.

Q. 62. Will you please state, if you know, why these loosely coupled open gap 126 meter transmitting sets were installed on U. S. battleships?

A. On account of the military necessity for communication between a given battleship and some other ship of the Fleet near by, simultaneous with communication between this battleship and some distant radio station. The latter communication was carried on from the main radio room of the battleship, using relatively long wave lengths. The former communication was carried on on short wave lengths from another radio room.

It was found in the first tests of this simultaneous operation, that if a quenched gap transmitter were used for the short wave, short range, transmission, it interfered with reception on the main antenna, even though this reception were at a very long wave length and with very selective apparatus. But when the loosely-coupled, open-type gap set, above described as the Inter-Fleet set, was used at the short wave length, it did not interfere with simultaneous reception on the main radio antenna. Thus this type of Inter-Fleet transmitter was adopted as standard.

[fol. 1175] Q. 63. Testimony has been given in this suit by defendant's witness Loftin and recorded on Printed Record pages 1116, 1119 and at other points, to the effect that the U. S. Government used certain types of Telefunken and Atlantic Communication Company receiving sets, of which the secondary circuits were untuned. Will you please state, if you know, what types of these sets were used by the U. S. Navy Department?

A. I am familiar with three types of receivers made by the Telefunken Company, which were used by the U. S. Navy. There was an upright type, which I think was Type E.5, which contained one variable condenser for use in tuning the antenna circuit. This was a two-circuit receiver, the secondary coil being tuned by means of moving a plug to any one of a number of tap-off points, the tuning being obtained by the inductance of the portion of the coil in use, and the distributed capacity of the coil. There was another upright type, which as I recall, was termed "Type GAHU", wherein there were two variable condensers, one used for tuning the primary as before, and the other for tuning the secondary when condenser tuning was used in this circuit. In this latter type, however, there was also a coil supplied for the secondary circuit, which

coil had a number of tap-off points, and when this coil was used, the secondary condenser was not in circuit. Under these conditions the receiver was the same in operation as Type E-5. There was a third type of Telefunken receiver, known as "Type E-4", this being a flat type of receiver. The tuning of the secondary of this receiver was likewise by picking off an inductance tap, and making use of the distributed capacity of the coil. I think that a switch was used for passing from one inductance pick-off to the other.

Q. 64. Do you know of any Navy receiving sets which were designed in the Navy that had secondary circuits tuned in a similar manner; if so, please give their designations?

A. I do not know of any sets which were designed in the Navy and which embodied this feature. However, a number of sets of this type were designed under Navy supervision; for example, the receivers of the portable sets made by the National Electrical Supply Company of Washington, D. C. I was detailed by the Bureau to assist and supervise the design of these sets, including the receivers. The receivers of the Battleship, Type B, Type C and Type D portable sets had their secondaries tuned by a change of secondary inductance, combined with the distributed capacity of the coil. I used these sets after their delivery to the Navy, both for experimental work and in actual communication.

Q. 65. Will you please state where you saw and used the Telefunken sets referred to in the previous answer before the last?

A. I have used all three Telefunken receivers of the type referred to on a great many Naval vessels and at Naval Shore Stations. I can recall some specific instances. I remember using, and making a drawing of, a flat E-4 type on the U. S. S. Maryland at the Isthmian Canal Zone in 1912. I recall using, and making a picture of, the two condensers GAHU set on the U. S. S. Arkansas, on Christmas week, 1913, while en route to the Canal Zone with President Taft. The upright E-5 type I recall using at the Portsmouth Navy Yard, about 1911, and also at the Norfolk Navy Yard.

[fol. 1176] Q. 66. Where was this Portsmouth Navy Yard you have mentioned located?

A. On the opposite side of the river from Portsmouth, New Hampshire.

Q. 67. To how many different wave lengths was the secondary circuit of the upright form of the Telefunken receiver sets capable of being tuned?

A. When this secondary coil was used without tuning condenser, it could be tuned to any wave length within the range of the coil, which was approximately 250 to 6,000 meters. At each tap position, the secondary coil system would respond to a band of wave lengths, and in passing from one tap position to another next to it, the wave length bands overlapped. There were six of such tap-off points on the coils of this nature that I recall.

Q. 68. Can you produce any physical apparatus which substantiates your testimony as to the six bands of wave lengths referred to in your last answer?

A. Yes. I have here a secondary coil of a Telefunken receiver, such as would be used with the Type E-5, or with type GAHU when no secondary tuning condenser was used. This coil is marked "Detector Coil", and is stamped with the serial number 1653, a further identifying number, 350, being painted on the coil. There are six plug positions around a portion of the rim, to each of which wires pass to tap-off points on the coil. In these sockets would be placed the plug used for picking off the number of turns best suited for the wave length to be received.

There are tabs or markers for each plug position. On these are engraved the Greek letter Lambda, meaning "wave length", followed by the sign of equality, and below these, two sets of figures separated by a dash and ending with the letter "m". The figures signify the upper and lower wave lengths of the band of wave lengths to which the coil system best responds when the plug is in the associated socket. The letter "m" stands for meters. The following table gives the stampings on the various markers:

<i>Plug Position</i>	<i>Wave Length in Meters</i>
1	200- 500 m.
2	500- 650 m.
3	650- 900 m.
4	900-1500 m.
5	1500-2500 m.
6	2500-6000 m.

Q. 69. Will you please state where you obtained this coil which you produced in answer to the last question?

A. This coil was loaned to me by Commander S. C. Hooper of the Bureau of Engineering, about the last of 1919, for use in measurement work. I wished this particular coil, which I had used in Naval work, because I knew its constants.

Q. 70. In whose possession has this coil been since you obtained it in 1919?

A. It has been continuously in my possession until I turned it over to the custody of Mr. E. W. Vaill some days ago.

Q. 71. Will you please state your preferences as to putting this coil you have produced, in evidence as an exhibit, and your reasons therefor?

A. I prefer not to introduce it as a physical exhibit, in that I have use for it from time to time, and I am under personal obligations to return it whenever called for.

[fol. 1177] Mr. Vaill: Counsel for claimant offers in evidence a photograph of this coil produced by the witness, with the understanding that the original coil may be produced at the hearing in this case, if desired, and the same is available to claimant's counsel, and it is requested that said photograph be marked as "Claimant's Exhibit No. 215".

(Said exhibit marked as requested.)

Q. 72. Will you kindly examine this "Exhibit No. 215" and state whether or not it correctly represents the coil you have produced?

A. It does.

Q. 73. Can you refer to a printed publication containing an illustration of the upright type of Telefunken set?

A. I find such an illustration on page 176 of Robison's Manual, 1918 Edition (Reproduced Opposite). The illustration is marked Fig. 100. It shows an upright form of Telefunken receiver in which there is only one tuning condenser, and the series-parallel switch for changing the position of this condenser to various portions of the antenna circuit is clearly seen. The secondary coil is shown with six taps and a plug inserted in one of them. This secondary is of the type wherein the tuning is done by the inductance of the coil and its distributed capacity.

Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of page 176 of Robison's Manual, 1918 Edition, and requests that the same be marked "Claimant's Exhibit No. 216".

(Said exhibit marked as requested.)

Q. 74. Can you refer to a printed publication explaining the effects upon tuning produced by variations of inductance and distributed capacity?

A. I find such an explanation in an article by Mr. Frederick A. Kolster, then with the United States Bureau of Standards, the article being headed "The Effects of Distributed Capacity of Coils used in Radio Telegraphic Circuits". This was published in Volume I, part 2 of the Proceedings of the Institute of Radio Engineers, April, 1913. On page 24 of this article, I find the following:

"Distributed capacity effects in the coils of the so-called untuned or aperiodic detector circuits are in many cases very striking, the result being that the circuit is not at all aperiodic but responds much more violently at a particular frequency, depending upon the natural period of the coil."

Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of page 24 of Volume I, Part 2, of the Proceedings of the Institute of Radio Engineers for April, 1913, and requests that the same be marked "Claimant's Exhibit No. 217".

(The exhibit marked as requested.)

Mr. Vaill: Counsel for claimant also offers in evidence a photostat copy of pages 538 and 539 of Robison's Manual of Radio Telegraphy and Telephony, Edition of 1924, referred to by the present witness in answer to Q. 14, and requests that the same be marked "Claimant's Exhibit No. 218".

(The exhibit marked as requested.)

Q. 75. Please refer to your answer to R. D. Q. 37 of your previous testimony given in this case, as found on page 250 of the Printed Record, where you stated that you made tests of a Navy Bellini-Tosi direction finder and that you made comparative tests of two electrode Fleming valves and a carborundum crystal detector in 1910 or 1911. Please also refer to the testimony of defendant's witness

John M. Miller, page 820 of the Printed Record, during which he comments upon your prior testimony and make any comments that may seem advisable, in view of Mr. Miller's testimony.

A. Referring to my answer to R. D. Q. 37, I wish to state that the tests referred to were made in 1914, and not in 1910 or 1911.

Referring to Mr. Miller's testimony on page 820 of the Printed Record, where he draws deductions from the Official Report which I made to the Navy Department on the above tests, I find that Mr. Miller has misquoted my report, and has made errors in his deductions. About three-quarters of the way on page 820 Mr. Miller states:

"So that we find the standard Navy crystal detector to be three and one-half times superior to the Fleming valve instead of the Fleming valve being twice as sensitive".

According to the ordinary rules of grammar, I understand that the phrase which is understood in this sentence is "as the standard Navy crystal detector", making the entire statement read:

"So that we find the standard Navy crystal detector to be three and one-half times superior to the Fleming valve instead of the Fleming valve being twice as sensitive as the standard Navy crystal detector".

With this understanding, Mr. Miller's statement is incorrect, in that my report stated that the Fleming valve was twice as sensitive as the carborundum detector. The standard Navy crystal detector at that time was the Galena detector.

Mr. Miller is in error in stating that it is found from my report that the standard Navy crystal detector was three and one-half times superior to the Fleming valve. As given on this same page 820, I found that the audibility of a given signal was 400 with the Galena crystal and 160 with the Fleming valve. The ratio of 400 to 160 is two and one-half, and not three and one-half.

In my answer to R. D. Q. 38, I testified that the valve was more sensitive than the crystal, specifically stating "possibly it was twice as sensitive". As I recall the tests in question, and as the Official Report shows, the main object of the tests was to obtain and furnish data primarily on the apparatus submitted for such tests, namely, the Bellini-

[fel. 1179] Tosi direction finder outfit. The detectors which were furnished with this outfit were a carborundum crystal and the Fleming valve, and my main comparison of detector sensitiveness was between these two elements of the outfit under test. That is why I stated in my answer to R. D. Q. 38 that the valve was twice as sensitive as the crystal detector. An auxiliary test was made, comparing the Galena detector and the Fleming valve, in which the sensitivities were respectively 400 and 160.

Q. 76. How much of a choice did you have in the use of Fleming valves in making the tests you have referred to in your last answer?

A. I think there were five operative valves submitted with the set, but as far as I know, I used only one valve in the above comparison between crystal and valve detector.

Q. 77. Did you make any comparison between the relative sensitiveness of the various valves themselves?

A. I probably did, though I have no specific remembrance of doing so.

Q. 78. In answer to Q. 20, page 799 of the Printed Record, defendant's witness, Mr. Miller, mentions the omission of choke coils from three of the circuits of "Plaintiff's Exhibit No. 116", "vacuum tube transmitters for radio telephony". What have you to say concerning this comment of Mr. Miller?

A. In the above reference, Mr. Miller states that the schematic drawings termed "De Forest", "Western Electric", and "General Electric (No. 2)", are inoperative because "this type of circuit to be operative requires a radio frequency choke coil in series with the plate battery B² in the diagrams of "Plaintiff's Exhibit No. 116".

In the light of my previous testimony, with the data at hand which is referred to in that testimony, the above statement of Mr. Miller is incorrect.

In my previous testimony, I stated on page 237 that the schematic drawings which are referred to above, were extremely simplified, and that they showed only the essential elements used to create oscillations in the antenna. About half way down this page I stated:

"B² represents the supply source for the plate voltage and this may be a generator or a battery".

On page 238, I furnished a table in which were given the actual wiring diagrams from which the several sche-

matic diagrams were made. Reference to each of these wiring diagrams shows that a generator was used as the supply source for the plate voltage.

When a generator is so used, the inductance of the armature is sufficient choke to permit of the apparatus functioning. I have used this identical circuit, without radio-frequency choke coils, many times in oscillating valve circuits, thus showing that such a circuit is operative, even though radio-frequency chokes are not present. In the circuits referred to by Mr. Miller as inoperative, radio-frequency choke coils are actually used in the sets themselves, but they are in the nature of safety devices, and are not "essential elements necessary to create oscillations in the antenna".

Q. 79. Referring to the original circuits from which your simplified diagrams were made, will you please state what effect, if any, would be produced if the generators shown [fol. 1180] in the plate circuits were replaced by batteries, as suggested in your last answer?

A. The original circuit from which the simplified drawing referred to as "DF" was made is given as Figure 10 in the publication which is "Plaintiff's Exhibit No. 117"; the original circuit from which the simplified drawing referred to as "GE No. 2" was made is given in Fig. 26 of the publication which is "Plaintiff's Exhibit No. 118"; the original circuit from which the simplified drawing referred to as "WE" was made, is given as Fig. 9 of the publication which is "Plaintiff's Exhibit No. 118". In all of these circuits, the set would be operative if the generators shown in the plate circuits were replaced by batteries.

Q. 80. Defendant's witness Mr. Miller, in answer to Q. 29, above referred to, also mentions "Plaintiff's Exhibit No. 116" and the circuit marked "General Electric Co. 2", stating:

"Mr. Clark has also omitted the grid leak resistance across the grid condenser '1'".

What have you to say in this connection?

A. The grid leak resistance was inadvertently omitted from the extremely simplified diagram referred to.

Cross-examination.

By Mr. Edwards:

X Q. 81. In your answer to Q. 75 you say that Dr. Miller has misquoted your report; are not the quotations made by him from your report and found on printed page 820 of his deposition correct quotations?

A. Mr. Miller states in part:

"I have looked up Mr. Clark's Official Report to the Navy Department on these tests. * * * I find that Mr. Clark compared * * * etc."

Following this, Mr. Miller gives other statements as to my report; I consider these statements as quoting from my report, and therefore I still consider that the report was misquoted in the particular sentence referred to in my answer to Q. 75.

X Q. 82. Do you deny that the quotations given by Dr. Miller from that report, and appearing in quotation marks on page 820 of the Record, are correct quotations?

A. Without having the report here to compare, I cannot definitely answer, but to the best of my knowledge, as I recall that report, the quotations appearing in quotation marks are correct.

X Q. 83. Do you deny that in that report you gave the audibility of the carborundum detector as 80, the audibility of the Fleming valve as 160 and the audibility of the Galena crystal at 400?

A. No.

X Q. 84. Do you deny that after the first few tests on the direction finder, the Galena detector was used for all tests?

A. No.

X Q. 85. Do you deny that in that Report you recommended that the carborundum detector and the Fleming valve be replaced by a more sensitive crystal detector, such as a Galena or silicon arsenic detector and a DeForest audion amplifier?

A. No.

X Q. 86. Is it not true that aside from the typographical error of indicating the audibility of the Galena crystal as three and one-half times superior to the Fleming valve, [fol. 1181] instead of two and one-half times, that the only criticism you have to make of Dr. Miller's testimony is that

he understood the Galena crystal to be the standard Navy detector, whereas, you contend that the standard Navy detector was the carborundum detector?

A. I have not made the statement that the standard Navy detector was the carborundum, but I have stated that the standard Navy crystal detector was the Galena at that time. Furthermore, in addition to the incorrect ratio of sensitiveness given by Mr. Miller, I have the further criticism that he states, by inference, if my understanding of the grammatical meaning of the sentence is correct, that he finds in my report that the Fleming valve was twice as sensitive as the standard Navy crystal detector.

X Q. 87. Do you deny that if the standard Navy detector was the Galena detector, that your report shows that the standard Navy detector was two and a half times as sensitive as that of the Fleming valve?

A. No.

X Q. 88. Then wherein did Dr. Miller misquote your report, except for the obvious error of indicating that 400 is three and a half times 160 instead of two and a half times?

A. In that I understand his statement

"So that we find the standard Navy crystal detector to be three and one half times superior to the Fleming valve instead of the Fleming valve being as twice as sensitive"

to mean that my report stated that the Fleming valve was twice as sensitive as the standard Navy crystal detector, and this statement is a misquotation of my report.

X Q. 89. I note that you do not complete the sentence of Dr. Miller's testimony from which you quoted. The Record shows that after the word "sensitive" there is a comma, and the sentence continues "as one would gather from Mr. Clark's testimony." Do you deny that in your first deposition in this case you testified to the effect that the Fleming valve, in this set which you tested, was possibly twice as sensitive as the crystal and that your own report introduced in this case now shows that the crystal was twice and a half times as sensitive as the Fleming valve?

A. Your statement is incorrect.

X Q. 90. Do you deny those facts?

A. In the form which you have presented them, I do.

X Q. 91. Will you point out wherein the statement is incorrect?

A. In that you refer in the 8th line of your X Q. 89 to "the crystal" being half as sensitive as the Fleming valve and in the 9th line to "the crystal" being twice and a half times as sensitive as the Fleming valve. By such use of the same words "the crystal" without further designation, I understand you to mean that the same crystal is meant by you in both cases, and with this understanding your statement is incorrect.

X Q. 92. Then I take it your position now is that when you testified previously in answer to R. D. Q. 38, page 250 of the Printed Record, you meant that the Fleming valve was possibly twice as sensitive as the carborundum detector; is that correct?

A. Yes, it is.

X Q. 93. At that time, why did you omit reference to the fact that the Galena detector was two and a half times as [fol. 1182] sensitive as the Fleming valve?

A. Because the main test which I made was a comparison of the apparatus furnished with the Bellini-Tosi outfit and my chief aim in the test was to obtain such data and comparison; the carborundum detector was a part of this outfit, the Galena was not. I gave the ratio which I found in my main test.

X Q. 94. At the time of giving this testimony you knew, did you not, that the Galena crystal was the standard crystal of the Navy at the time the tests were made?

A. Yes.

X Q. 95. At the time of giving this testimony you knew, did you not, that when making the test, you had compared the Fleming valve with the Galena crystal, as well as the carborundum crystal?

A. I may have recalled it, but I do not definitely know.

X Q. 96. And you knew at the time of giving that testimony that the obvious purpose of the question which you were answering was to enlighten the Court upon the comparative performance of the Fleming valve and crystal detectors?

A. I did not consider that phase of the matter, but answered the specific question asked me as to certain tests made with the Bellini-Tosi direction finder.

X Q. 97. Was there anything in the question asked you which indicated that the answer was to be confined to carborundum crystals only, so far as you recollect?

A. Yes.

X Q. 98. What is your recollection?

A. To the best of my present knowledge, I was asked to give testimony as to tests made with the Bellini-Tosi direction finder, and I confined my answer to the tests which I made with this direction finder; the Galena detector was not a part of the Bellini-Tosi outfit. I understood that I was being asked as to the tests made with this outfit, and, as I recall, the question was so worded.

X Q. 99. I will ask you to look at page 250 of the Printed Record and note that Q. 37 asked you if you had had occasion to compare the sensitiveness of the two-element vacuum tube detector and "the crystal detector"; that you replied that you had made "a number of such tests" "in connection with" a Bellini-Tosi direction finder, and that then Q. 38 asked "What was the result of the comparison?" In view of that record, I will ask you if you do not think that your answer would have been more enlightening to the Court, and at the same time fairer, if you had pointed out that your answer only applied to the carborundum detector and that at the same time you had also compared the Fleming valve with the standard crystal detector of the Navy, the Galena detector, and found the Galena detector to be twice and a half times as sensitive as the Fleming valve?

A. I could have made my answer contain much more information than it did, by pointing out a number of other tests besides the main one which I used as the basis of my reply. Undoubtedly it would have been more enlightening had I added the comparison of the Galena and valve, and I might also possibly have given the Court more information by stating that in comparing the valve with one type of crystal detector, I found the former twice as sensitive, and with another type of crystal detector, less than half as sensitive, so that, in general, the valve and the crystal detectors used in the tests were of the same general order of sensitiveness. I do not admit the correctness of [fol. 1183] your word "fairer" in your question. My answer was given with strict adherence to fact, and in all fairness.

X Q. 100. I will ask you now if you think Dr. Miller was unfair, or unjustified, in assuming that your previous testimony was to the effect that the Fleming valve was twice as sensitive as "crystal" detectors, without limitation to whether the crystal was carborundum or Galena?

A. I do not know that he did so assume. I find no reference to such an assumption in his testimony.

X Q. 101. Is it not a fact that the only basis you have for charging that Dr. Miller misquoted your report and made errors in his deductions, is that the text of his answer reads "three and one-half" instead of "two and one-half" as the figures obviously indicate, and that when he said that your report showed the standard Navy crystal detector to be superior to the Fleming valve "instead of the Fleming valve being twice as sensitive, as one would gather from Mr. Clark's testimony", he was not a mind reader, and did not know that your testimony contained a hidden qualification to the effect that the crystal you referred to was a carborundum crystal, although you knew at the time that the standard Navy crystal was two and a half times as sensitive as the Fleming valve?

A. It is not a fact that my only basis for stating that Mr. Miller misquoted my report is the numerical error above referred to. I also consider that, based on the actual wording of his statement, a second error was made by him. The sentence on line 24 of page 820 of the Printed Record, beginning "So that we find the standard Navy crystal detector . . ." is an incomplete sentence, in that he starts a comparison by the phrase "the Fleming valve being twice as sensitive" without completing the sentence, and stating what it was that the Fleming valve was twice the sensitiveness of. From ordinary grammar, the understood phrase thus left out must refer to the matter in the rest of the sentence, namely, the standard Navy crystal detector. Thus if he gathers from my testimony that I said the Fleming valve was twice as sensitive as the standard Navy crystal detector, he misquoted my testimony.

I do not know whether Mr. Miller is a mind reader or not, but I think it fair to assume that he has the normal memory of a human being; therefore, when he made his statement regarding the standard Navy crystal detector, and its relation to the Fleming valve he cannot have forgotten that four lines above he himself stated that the

Galena crystal was the standard Navy detector. Therefore, he was not in any way in the dark as to what he was talking about.

X Q. 102. But I remind you again that you do not quote the complete sentence of Dr. Miller and omit that part referring to "twice as sensitive, as one would gather from Mr. Clark's testimony." Do you think there was anything in your former testimony that gave any indication that the crystal was not a standard Navy crystal, but was a carborundum crystal?

A. My former testimony did not state the type of crystal, but in the sentence in which I consider Mr. Miller misquoted me, he had my complete Report at hand and gave the actual figures and types of detector just a few lines before this sentence. He cannot be going entirely from my testimony, since in my former testimony, I did not state that the standard Navy crystal detector was three and a half times superior to the Fleming valve, and yet the phrase "as one would gather from Mr. Clark's testimony" reads as clearly on that statement as it does on the statement that the Fleming valve was "twice as sensitive."

X Q. 103. You understand, do you not, that Dr. Miller was comparing your Report on the one hand, with your testimony on the other?

A. Yes.

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X Q. 104. In your direct examination you referred to certain sets, such as the Slaby-Arco transmitters, which employed artificial cooling means in connection with open gaps. Is it not a fact that the artificial cooling means, such as air blowers, tends toward making the gap act like a quenched gap?

A. I have observed no phenomena in using sets with open gaps thus artificially cooled, which would lead me to consider them as acting like quenched gap sets.

[fol. 1185] X Q. 105. Would you consider that the cooling means, such as blowers, tends to interfere with, or prevent, maintaining the gap active for a long time?

A. That is a matter which I never actually observed or made measurements of.

X Q. 106. Can you express any opinion on the subject?

A. I prefer not to, as I wish to continue my testimony as a fact witness, dealing with observed facts and measurements.

X Q. 107. Can you express any opinion on the subject?

A. I have never made any measurements or observations on this matter, and therefore cannot express any opinion based on my own knowledge.

X Q. 108. Have you theoretical knowledge sufficient to enable you to express an opinion on the subject?

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A. As in all previous cases where I have testified on radio matters, both for the United States Government and for private companies, I then confined my testimony and wish to confine my present testimony, to actual observations, measurements, and other physical operations which I have personally done or witnessed. This is what I mean by stating that I wish to give "fact testimony". I understand X Q. 106 to call for an opinion, and again I answer it by stating that I cannot give an opinion based on actual observations.

X Q. 109. Can you not answer X Q. 108 with a simple affirmative or negative?

A. I do not consider that I have sufficient theoretical knowledge to express the opinion referred to.

X Q. 110. It is a fact, is it not, that the cooled gaps to which you referred in your direct testimony, had a very considerably limited use, and have now substantially, if not entirely, disappeared?

A. In the early days of radio, say around 1909, or thereabouts, open gap transmitters formed the great majority of transmitting sets, and to my best present knowledge, about one-half of these transmitters had the spark gap cooled by artificial means. Therefore, I should not say that such sets "had a very considerably limited use." It is a fact that this type of set has now substantially disappeared.

X Q. 111. In your answer to Q. 13, you described the method used by you, in tuning quenched gap transmitters. [fol. 1186] And in step (c) you say that next you adjusted the secondary or antenna circuit "to resonance" with the primary. In doing this did you employ a wave-meter to measure the frequency in the secondary circuit?

A. Not in the act of adjusting the secondary circuit to resonance with the primary, to which you refer.

X Q. 112. The only circuit which you measured with a wave-meter was the primary circuit, was it not?

A. No, I also measured the wave length of the secondary circuit, but not in the act of adjusting this circuit to resonance with the primary, to which action your previous question referred.

X Q. 113. When did you use the wave-meter in measuring the frequency of the secondary circuit?

A. After all adjustments had been made putting the set into operative condition.

X Q. 114. You did not first tune the primary circuit to the desired wave length, measure it with a wave-meter, then tune the secondary circuit uncoupled, to the desired wave length, and then couple the circuits together and leave the circuits in their original adjustment, did you?

A. No.

X Q. 115. I take it from your answer to Q. 13, that when you followed out the procedure set forth in your answer you did not at all times, if ever, find that the antenna wave length was of the same frequency as the primary wave length; is that correct?

A. That does not agree with my recollection of my answer. I did frequently find that the antenna wave length, after the set was properly coupled, differed somewhat from the original wave length to which I had first adjusted the primary circuit, but I also found that this primary circuit, when the set was coupled, did not have the same wave length as it had when tuned alone. By re-adjusting both circuits I was always able to get the right or desired wave length in the antenna, and after this re-adjustment, both the primary and the secondary were substantially of the same wave length.

X Q. 116. I note that you qualify your last answer by saying "substantially" and also that in your direct examination for example, in your answers to Qs. 19, 40, 46, 47 and 55, and doubtless elsewhere also, you refer to the wave lengths or resonance being "the same or substantially the same". Do you draw any distinction between whether the frequencies are the same, or substantially the same?

A. No, I do not, because I could not find any difference in the ability of the transmitter to function properly, whether the primary and secondary final wave lengths were exactly the same, as they sometimes were, or whether they differed from each other by a few meters.

X Q. 117. Would you still subscribe to your testimony in this case if the words "or substantially the same" be

stricken out at the places indicated, and elsewhere throughout your deposition?

A. Where my testimony referred to measurements that I made, I would not subscribe to this testimony when the words "or substantially the same" were stricken out, because that would not be in accordance with the facts as I found them. However, I have stated in my answer to the previous question that at times I found the final wave lengths in both circuits to be the same, and in these cases I would subscribe to my testimony with the words referred to stricken out.

[fol. 1187] X Q. 118. If, for example, each circuit has a frequency of 900-meter wave length, I take it that you would then say that both circuits are in resonance; am I right?

A. Yes.

X Q. 119. Suppose one circuit is tuned to a wave length of 900 meters and the other circuit tuned to a wave length of 895 meters, have they the same frequency, and are they still in resonance?

A. From the viewpoint of adjusting a transmitter, my experience is that I would find such sets substantially in resonance from an operating viewpoint. Of course, they are obviously not in exact resonance.

X Q. 120. If one of the circuits is tuned to 900 meters and the other circuit to 850 meters, are they still in resonance?

A. I would not have adjusted a transmitter for use with such difference in wave length, for my best remembrance is that it would not operate satisfactorily. I would consider this difference in wave length to be beyond that tolerance allowable for the word "resonance" in operation.

X Q. 121. If one of the circuits is tuned to 650 meters, for example, and the other circuit is tuned to 550 meters, for example, would these circuits be in resonance?

A. I would not consider such a transmitter to be in operative resonance.

X Q. 122. If one circuit is tuned to 200 meters and the other to say 250 meters, would the circuits be in resonance?

A. I would say not.

X Q. 123. Can you give any indication as to how much of a departure from exact resonance can exist before it would cease to be substantially in resonance, according to your definition?

A. That would be entirely a matter of the conditions under which the set might be installed. My criterion in every case was to obtain an operative set, that is, emitting the right wave length, sharply tuned, with the radiation which my experience told me was satisfactory for the power used, and with the note good. Many of these conditions would vary in different locations, and what allowable difference in wave length could exist between primary and secondary would entirely depend on local conditions. In my answers to all the above questions, I tried as best I could to recall actual measurements with wave lengths about the same as those you refer to, but I could not give any numerical value as to a hard-and-fast allowable difference in wave length between primary and secondary which would not noticeably affect the operation of the set.

X Q. 124. I take it, then, from your last answer, that your criterion in determining whether or not two circuits have the same wave length, or are in resonance, depends not upon whether or not the product of the inductance and the capacity of each circuit is the same, but rather upon whether or not you were getting the wave length and radiation which your experience told you was satisfactory for the power used and the particular location; am I correct?

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[fol. 1188] A. I do not consider your statement correct. My criterion, in tuning a transmitter of resonance was the indication of some circuit capable of showing resonance by a maximum reading of some current-indicating device. For example, I measured the primary circuit by adjusting it until it gave a maximum deflection of an ammeter in a wave-meter circuit, the wave length of which wave-meter circuit was known to me from tables. I did not adjust the primary circuit to its wave length by measuring the inductance and capacity and multiplying them together. I adjusted the secondary circuit for maximum current in it, and thus again obtained resonance. After coupling the circuits, if the antenna wave length still remained the same as before, as it sometimes did, my criterion as to whether or not the circuits were "substantially in resonance" then became one of operative efficiency. I knew from previous experience that if there was material difference between the two wave lengths, the antenna would not be sharply

tuned and would not radiate the energy that should be sent out. Thus the amount that the primary circuit might differ from the secondary was entirely based on whether or not said difference was sufficient to affect the over-all operation of the set.

X Q. 125. In making the adjustments of quenched gap sets, as referred to in your answer to Q. 13, from what part of the primary coil did you take the measurement with the wave-meter?

A. In the first measurement of primary wave length, with the antenna circuit very loosely coupled and out of tune, the wave-meter was coupled with the operating portion of the primary coil itself. In re-measuring the primary wave length, after the antenna was tuned and coupled, this could not be done, because the wave-meter coil, under such conditions, would also be coupled with the antenna coupling coil. It then became necessary to couple the wave-meter to some part of the primary circuit where the wave-meter coil would pick up energy from the primary circuit only. Just where this would be would depend on each particular installation.

X Q. 126. At what part of the antenna circuit would you couple the wave-meter?

A. To the ground lead at a location where the primary circuit did not affect the wave-meter.

X Q. 127. What part of the circuit do you refer to as a "location in the ground lead where the primary circuit does not affect the wave-meter"?

A. That, of course, would depend on the particular installation under test. It was always possible to locate the wave-meter close to some portion of the ground lead, in such a position or location that the primary circuit did not affect it.

X Q. 128. Can you give us a specific example of such a location?

A. Not in feet and inches along a strip of copper unless a specific installation were mentioned.

X Q. 129. I mean relative position such as between certain parts of apparatus located in the circuit.

A. The ground lead usually consisted of a copper strip running from a terminal on the wave changer to either the metal bulkhead of a ship, or to the grounding system of a Shore Station. Coupling the wave-meter coil to such

a strip, preferably as far away as possible from the set, and furthermore, adjusting the position or orientation of the wave-meter coil so that it would not take up any energy from the primary circuit, it was always easily possible to have the wave-meter affected only by the secondary circuit.

X Q. 130. Referring to your answer to Q. 21 and to the resonance curves shown on page 156 of Robison's Manual for 1911, it is a fact, is it not, that the diagram and text show that the resonance curve for the aerial, which curve is marked I, was taken at the place marked "Aerial Inductance"?

A. The curve so states.

X Q. 131. And both of these curves were taken after all adjustments were made, including the coupling, were they not?

A. The curves indicate that to me.

X Q. 132. And the curve showing the wave length II was taken by a wave-meter coupled to the "Primary Variometer" also in the antenna circuit, was it not?

A. The curve indicates that the wave length II was taken in the manner you describe. The primary variometer is in both the antenna and primary circuits.

X Q. 133. And it is a fact, is it not, that on page 157 of this publication, the following explanatory matter appears:

"Fig. 102 shows much steeper curves taken from a direct connected quenched gap, 500 cycle set.

"The position of the two small humps in curve I, fig. 102, taken at the primary variometer indicating a coupling of

$$1070 - 860$$

$$\frac{\quad}{975} = 22\%.$$

This is by no means very loose coupling, but the curve shows that the aerial radiates most of its energy while oscillating in its natural period (in this case 975 meters) and that when so oscillating it is persistent enough to permit very sharp tuning.

"Curve II in fig. 102 taken at the aerial inductance shows but one maximum which practically coincides in wave length with the maximum of curve I. (Curve II is drawn to a different scale, so that the coincidence in maximum

readings is only apparent. They are in reality smaller for the open than the closed circuit.)”?

A. Yes.

X Q. 134. Referring to your answers to Qs. 67 and 68, do you consider that if the antenna circuit is adjusted to a frequency of 250 meters, for example, and the plug position is 1, for example, that under these circumstances the secondary circuit is in resonance with the antenna?

A. Yes.

X Q. 135. Do you consider this to be resonance, or substantial resonance?

A. I prefer to call it broad tuning resonance. By “substantial resonance”, I mean the condition between two sharply tuned circuits where the peak wave length of one differs only slightly from the peak wave length of the other.

[fols. 1190-1191] X Q. 136. Do you consider that the wave length of the secondary circuit which, as I understand your testimony, is tuned to a band of wave lengths, is in resonance with any particular frequency within the limits of the band; is that correct?

A. In broad resonance with it, yes.

X Q. 137. Is it not a fact that a circuit which is tuned to a band of wave lengths, or, as you call it, “broad resonance”, of say 200 meters to 500 meters, is not, in fact, tuned to any particular frequency within those limits?

A. No, it is broadly tuned to all of them.

X Q. 138. But it is not “sharply tuned” to any particular frequency, is it?

A. No.

X Q. 139. And is it not a fact that according to your own definition, two circuits to be in resonance should be sharply tuned to each other, or substantially so?

A. I request that you quote my definition to this effect. If I made such definition, it was for a specific instance.

X Q. 140. Well, is it or is it not your understanding that in order for two circuits to be in resonance, they should be sharply tuned to each other, or substantially so?

A. My experience has been that a circuit can be in resonance with another, whether the tuning of this circuit be sharp or broad.

X Q. 141. Can you answer X Q. 141 with a simple affirmative or negative?

A. Such an answer would not give the best information that I can give.

X Q. 142. Can you answer X Q. 140 with a simple affirmative or negative?

A. It cannot be so answered by me.

Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

Deposition closed.

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[fol. 1192] *Deposition of Roy A. Weagant, for Claimant, taken at New York, N. Y., on the 28th day of December, A. D., 1926.*

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First Interrogatory by the Notary. State your name, your occupation, your age and your place of residence; whether you have any, and if any, what interest, direct or indirect, in the claim which is the subject of inquiry; and whether, and in what degree, you are related to the claimant.

Answer. My name is Roy A. Weagant; age, 45 years; occupation, Consulting Engineer; residence, Douglaston, Long Island. I have no interest, direct or indirect, in this claim and am not related in any way to the claimant.

Direct examination.

By Mr. Vaill:

Q. 1. Are you the Roy A. Weagant who has heretofore testified in this case and in the case in the Southern District of New York entitled Marconi Wireless Telegraph Company of America against DeForest Radio Telephone & Telegraph Company as a witness for the plaintiff in the main case and for defendant on the supplemental proceedings?

A. I am.

Q. 2. What has been your experience in the art of radio [fol. 1193] engineering since your previous testimony in this case?

A. At the time of giving my previous testimony I was Chief Engineer of the Marconi Wireless Telegraph Com-

pany of America. When that company was merged into the Radio Corporation of America, I became Consulting Engineer engaged in special research and investigation work. In addition to this I represented the Radio Corporation in various conferences in Europe and visited all of the great radio stations of Europe and the various manufacturing plants of the large radio companies. I also represented the Radio Corporation at the Pan-American Radio Conference in Mexico, during which matters pertaining to governmental regulation of radio were discussed.

Since testifying previously, I have received from the Institute of Radio Engineers the Morris Liebman Memorial Prize for my work in the reduction of static interference. I was also, for a period of something over a year, Vice-President and Chief Engineer of the DeForest Radio Telephone & Telegraph Company, which manufactures a variety of radio appliances, including the three-element vacuum tube.

Q. 3. Please state what you have been requested to do in this case with reference to two-element high vacuum oscillation valves or tubes as concerns demonstration of radio frequency oscillations and reception of signals?

A. I have been requested to demonstrate a two-electrode vacuum tube receiving broadcast signals and oscillating; also to demonstrate that the oscillations produced by this two-electrode tube could be picked up by a receiving instrument and thereby illustrate the use of this tube as a radio transmitter.

I have also been asked to demonstrate the two-electrode tube in one or more stages as an amplifier of radio signals.

Q. 4. Will you now demonstrate to those present the capability of the hard or high vacuum two-element tube to oscillate and receive broadcast signals, and in doing so please produce a diagram showing the circuit connections and giving the electrical characteristics thereof; also explain how the oscillations are produced so as to heterodyne with incoming radio frequency waves?

A. I now proceed to demonstrate with the apparatus before us a two-electrode tube as an oscillator, and produce a diagram (Reproduced Opposite) which illustrates the circuit connections (producing a paper). In this diagram *n* represents the antenna, *R* represents a variable condenser of conventional type, *m* an inductance, *o* the earth connection, all of the above constituting the antenna circuit.

Coupled to coil *m* is coil *k*, which is connected through lead *j* to the plate *c* of the two-electrode tube and through the other lead *j* through a battery *p*, telephone *l* to the filament *b* of the two-electrode tube. The filament is heated from a battery *h*, which is controlled by a resistance *R*₁. In the arrangement which I have set up here the two-electrode tube is placed close to the condenser *R* where it is under the influence of the electrostatic field which exists on condenser *R*.

I now light the filament of the two-electrode tube, and by an adjustment of condenser *R* the words and music from a broadcasting station may be heard.

Mr. Vaill: Opportunity is now given to counsel for defendant to listen to the broadcasting through the headphones and observe the effects described by the witness.

(Mr. Edwards listens with the headphones.)

[fol. 1194] Mr. Edwards: Counsel notes that he hears dots and dashes and nothing else.

(Mr. Edwards again puts on the earphones.)

Mr. Edwards: A few musical notes were heard and then more dots and dashes.

A. (continued) I will next, by a slight change of the coupling between the coils *m* and *k* make the tube oscillate, and this will be made evident by the whistle, which is the common way of showing that oscillations exist in a receiving tube.

Mr. Vaill: Opportunity is given opposing counsel to listen to the heterodyning effect of the whistles described by the witness.

(Mr. Loftin listens with the headphones.)

A. (continued) It will be noted that the oscillations take place over a wide range of coupling.

(Mr. Edwards listens with the headphones.)

Mr. Edwards: I hear squeals.

A. (continued) I will next show that the oscillations produced by the tube and apparatus just demonstrated can act as a transmitter and be picked up by an oscillating receiver in the neighborhood. I will show that a note is pro-

duced by the apparatus just demonstrated in the receiver which will be used to detect the oscillations. I will then vary these oscillations and demonstrate that these variations are heard in the usual receiver.

(Some adjustments are then made by the witness.)

A. (continued) A variable musical note can now be heard in the receiver, the variations in this note corresponding to the touching of a part of the first apparatus and it now can be heard by those present.

Mr. Vaill: Opportunity is now given to defendant's counsel and Mr. Loftin to listen to this demonstration.

(Mr. Loftin, Mr. Edwards and Mr. F. N. Waterman, in turn, listen by means of the headphones.)

Mr. Vaill: It is noted that defendant's counsel and Mr. Loftin have listened through the headphones.

Q. 5. Will you please now explain the relation of the oscillating two-element tube in the circuit before us on the table, indicating how the oscillations are produced as indicated by the heterodyning action?

A. One side of condenser R, namely, the side which is connected to inductance m, is close to the glass of the two-electrode tube at a point midway between the two electrodes. This physical association of the apparatus results in the electric field which exists on condenser R affecting the electron stream which passes between the hot electrode a and the cold plate c, giving thereby an electro-static control of the electron flow. As the result of this control, this arrangement is able to oscillate, since small electro-motive forces on this condenser can release relatively greater amounts of energy flowing between the plate c and the filament a.

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Q. 6. Will you now demonstrate the capability of the hard or high vacuum two-element tube to amplify broadcast signals by one or more stages of amplification; also please produce a diagram and explain the connections of the circuits?

A. I will now do so with the apparatus before us: I now [fol. 1195] produce a diagram showing an arrangement of four two-electrode tubes, one of which at the right of

the diagram is used as a detector, the other three being amplifiers. In the arrangement illustrated in this sketch I am able, by throwing a switch marked s, to throw the antenna connection so that it is connected to the oscillating circuits of the two-electrode tube, or so that it is connected to the input circuit of the first amplifier and thereby puts the amplifier into action. An additional switch s' is opened when the amplifier is not working, because when closed it slightly reduces the intensity of the signal received by the two-electrode tube.

I will now show you a signal as received by the two-electrode detector without the amplifier from the local broadcasting station WEAF. It is now ready for anybody who wants to listen.

Mr. Vaill: Opportunity is given at this point to opposing counsel and Mr. Loftin to listen to the effects described by the witness.

(Mr. Loftin puts on the headphones.)

A. (continued) The signal which you hear now is that received by the detector alone.

(Mr. Edwards puts on the headphones.)

A. (continued) Now I will throw to the amplifier if you will put the phones on.

(Mr. Loftin, Mr. Edwards and Mr. Waterman, in turn, put the headphones on.)

A. (continued) The intensity of the responses as received with the amplifier in circuit, that is to say, with the three two-electrode tubes arranged for the purpose of amplifying, is very much greater than that received by the detector alone, I should say at least one-hundred times as loud.

The diagram which I have produced represents everything which is in the physical apparatus which I have just demonstrated, and can be checked detail by detail.

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Q. 7. Will you please state the degree of vacuum as far as possible in the various tubes which you have been using in the sets which you have been demonstrating?

A. These tubes were made to have the same order of vacuum as that produced by modern processes for the three-

electrode tube. In other words, the vacuum is extremely high, of such an order that the residual gas plays no part in the action, and, for practical purposes, may be considered a perfect vacuum.

Q. 8. Will you now kindly state whether or not the apparatus shown in the diagram, "Claimant's Exhibit No. 225", first produced by you corresponds with the apparatus on the other table in which the set was used for producing oscillations, reception and transmitting?

A. This diagram does so correspond.

Q. 9. Will you kindly describe these high vacuum two-element tubes which you have mentioned, giving the structural features so that the court may understand from the record how they are constructed?

A. These high vacuum two-element valves consist of a cylindrical tube approximately one inch in diameter by about four inches long. The filament is in a roughly circular form supported by wires attached to the glass stem coming in from one end. The plate is a circular disc of metal slightly smaller in diameter than the inside of the glass [fol. 1196] tube. The spacing between the electrodes is approximately a half inch for the oscillator and the amplifier tubes, and approximately a quarter of an inch for the detector tube. There is a film having a somewhat mirror-like appearance on the inside of the tubes between the plate and the end of the tube, which is due to the flashing which is incident to the process of exhausting the tubes, and is the same thing as is seen in the modern commercial type of three-electrode vacuum tube.

Q. 10. Will you kindly now describe the relations between the various amplifying tubes and the transformers used in connection therewith?

A. In the arrangement of the amplifier tubes in the apparatus which I have just demonstrated the two-element vacuum tube is arranged so that the glass of the tube is close to one end of the winding of the input circuit. This is illustrated in the diagram which I have produced, where it will be noted that one end of coils L_3 , L_5 and L_7 are close to the two-electrode tube. This end of the coil is what is commonly referred to as the high potential end, and it is the electric field from this coil which influences the electron stream in the tube, with the result that the two-electrode tube functions as an amplifier.

Q. 11. Does your description of the amount of vacuum in the tubes which you have been using apply to the tube used in the oscillating demonstration first made by you?

A. It does.

Q. 12. Can you produce a diagram of the receiving set used in connection with the oscillations produced in the first demonstration you made of the transmitting capability of the two-element vacuum tube?

A. I produce a rough pencil sketch showing a conventional three-electrode regenerative circuit.

Mr. Vaill: The diagram produced by the witness in response to the last question is offered in evidence as "Claimant's Exhibit No. 223."

The apparatus first used by the witness in demonstrating the reception of broadcast signals and the oscillating effect and the transmitting effect is offered in evidence as "Claimant's Exhibit No. 224".

The diagram produced by the witness showing the connections of Exhibit No. 224 is offered in evidence as "Claimant's Exhibit No. 225".

The detector and three stages of radio frequency amplification demonstrated by the witness is offered in evidence as "Claimant's Exhibit No. 226".

And the diagram produced by the witness in connection with said receiving set of Exhibit 226 is offered in evidence as "Claimant's Exhibit No. 227".

(The Exhibits were respectively so marked by the Notary.)

[fol. 1197] Q. 13. Referring to the apparatus constituting Claimant's Exhibit No. 224, which you yesterday caused to oscillate and produce transmitting waves which were received on the receiving apparatus on the adjacent table, will you please state what distance you have actually received signals out doors by such an apparatus?

A. I have made a test in which I received signals from a two-electrode vacuum tube oscillating from the same circuit which I demonstrated yesterday, a distance of approximately one-half mile away.

Cross-examination.

By Mr. Edwards:

X Q. 14. Was the tube which you used in the instance just referred to by you the same tube as one of those employed in these experiments performed by you in our presence yesterday?

A. I believe it was.

X Q. 15. Which one?

A. That I am not able to say, but I believe it was either one of the three tubes used as amplifiers or the tube used as an oscillator in the demonstration yesterday.

X Q. 16. That is, you would identify this tube as being No. 663, 642 or 644, the tubes present in this apparatus?

A. Yes, it includes these tubes of Claimant's Exhibit No. 226 and tube No. 665 of Claimant's Exhibit No. 224; that is, I believe the tube used in the test to which I referred was one of these four tubes.

X Q. 17. That is, either 665, 663, 642 or 644?

A. Yes.

X Q. 18. But you are unable to identify which one of these it was?

A. No, I am not able to.

X Q. 19. How long were you connected with the Marconi Wireless Telegraph Company?

A. From 1912 until the formation of the Radio Corporation in 1920.

X Q. 20. Did you continue in the employ of the Radio Corporation from the time it was organized?

A. Yes, I did.

X Q. 21. How long did you remain with the Radio Corporation?

A. Until the fall of 1924.

X Q. 22. What was the occasion of your leaving the Radio Corporation?

A. I resigned.

X Q. 23. Was there any especial reason for that?

A. No, I guess not, except that I thought I wanted to do something else for a while.

X Q. 24. At that time what was your position with the Radio Corporation?

A. Consulting Engineer.

X Q. 25. And what was your position with the Marconi Company?

A. Chief Engineer.

X Q. 26. How long after you left the Radio Corporation did you engage in other employment?

A. About a year.

X Q. 27. And what employment was that?

[fol. 1198] A. I was Vice-President and Chief Engineer of the DeForest Radio Telephone & Telegraph Company.

X Q. 28. And how long did you continue in that position?

A. Actively about a year.

X Q. 29. Are you still connected with the DeForest Company?

A. No, I am not.

X Q. 30. Are you at present in the employ of or retained by the Radio Corporation?

A. I am retained by them as Consulting Engineer, that is to say, I have an office of my own and I am doing some work for the Radio Corporation, but I am not directly in their employ.

X Q. 31. You have frequently given testimony for the Marconi Company and Radio Corporation, have you not?

A. Yes, I have.

X Q. 32. In giving this testimony, was the nature of it in general the making of demonstrations such, for example, as you made here yesterday, except, of course, designed to illustrate other operations?

A. I have in the course of previous testifying, conducted a number of demonstrations.

X Q. 33. These demonstrations have been in practically all cases on behalf of the Marconi Company or the Radio Corporation or allied interests, have they not?

A. Usually, yes, although I believe I testified once for the DeForest Company.

X Q. 34. In what case did you testify for the DeForest Company?

A. It was a case having to do with the Armstrong Patent.

X Q. 35. You testified for the Marconi Company in the case of the Marconi Company against the DeForest Company on the Fleming patent, did you not?

A. Yes, I did.

X Q. 36. In the main trial you made demonstrations purporting to show that the early DeForest patents employing

heat other than an incandescent filament were uncommercial or useless, did you not?

A. I have a dim recollection of having made some tests, with a flame detector, but I have forgotten the details and general significance of these tests.

X Q. 37. You also demonstrated or assisted Mr. Waterman in demonstrating in the same case the action of a two-electrode audion for the purpose of showing that it would oscillate, did you not?

A. I believe I made some tests and demonstrations showing that a two-electrode vacuum valve would generate oscillations.

X Q. 38. In that demonstration, the circuits employed were those shown in the sketches entitled "Plaintiff's Exhibit No. 2" and "Plaintiff's Exhibit No. 3" appearing on pages 87 and 88 of the Record in this case, were they not (showing the sketches to the witness)?

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A. The diagrams referred to appear familiar, and, as near as I can recollect, were the ones which I used in the demonstrations referred to.

X Q. 39. You recall, do you not, that the two-electrode tube was used in the transmitter as shown in the drawing on page 87 of Claimant's Exhibit No. 171 in this case, and that in the receiver employed in the tests a three-electrode tube was used as indicated in the drawing on page 88 of Claimant's Exhibit 171?

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[fol. 1199] A. I recollect that the combination referred to was used in some demonstration.

X Q. 40. Did you attempt to use any of the two-electrode tubes forming part of your demonstrations here in the transmitter circuit shown on page 87 to which we have just been referring?

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A. I was requested to demonstrate a high vacuum tube oscillating, and I did not use any others in this test.

X Q. 41. Any other what, circuits or tubes?

A. Any other tubes.

X Q. 42. (X Q. 40 was repeated to the witness by request of Mr. Edwards).

A. I did not.

X Q. 43. Do you understand that any of the tubes in your present demonstration would operate in the circuit shown on page 87 of Claimant's Exhibit 171 in the Record in this case to produce the same results as were attained in the demonstration before Judge Mayer or to produce the same results which you claim to have produced here?

A. I have not attempted to use the tubes which I demonstrated yesterday in the circuit shown on page 87 of the exhibit mentioned.

X Q. 44. Is it your understanding that if the tubes or any of them used in your tests here were inserted in a circuit like that shown on page 87 of Claimant's Exhibit 171 in this case, you would obtain the same results as you have demonstrated here with the apparatus which you have demonstrated here?

A. There is only one possible way in which I could answer that question; that is by trying it, which, as I have already said, I have not done.

X Q. 45. Have you ever experimented with hard tubes in a circuit like that shown on page 87 of Claimant's Exhibit No. 171?

A. Not so far as I recollect, if by "hard tubes" you mean tubes having the order of vacuum of the modern three-electrode tube.

X Q. 46. Do you undertake to say that if any of the tubes which you have produced here are employed in a circuit like that shown on page 87 of Claimant's Exhibit No. 171, you can make the tube amplify or oscillate?

A. I can hardly make such an assertion, due to the fact, as previously stated, that I have not tried it.

X Q. 47. Can you offer any explanation as to why you employed the circuit shown on page 87 of Claimant's Exhibit 171 in making the demonstration before Judge Mayer and not employing the circuits which you have employed here as shown in Claimant's Exhibits 225 and 227 using the tubes which you have here?

A. Certainly; I used the circuit shown on page 87 of the Record because I had found by experiment that that circuit, with the tubes which I happened to have at the time I was requested to make that demonstration, would work, and I used the circuit which I demonstrated yesterday because that happened to be a circuit which I knew would work with a hard tube as the result of experimental work which I did years ago.

X Q. 48. Having demonstrated as you believe, before Judge Mayer that a two-electrode tube would oscillate in the circuit shown on page 87 of Claimant's Exhibit 171, [fol. 1200] did it not occur to you that it would be natural to employ the tubes which you have produced here to-day in the same circuit?

A. Not necessarily at all. As one goes on with engineering work of this sort, new information is obtained, and an experimenter seldom feels bound by anything which he has done previously, but when requested to make a demonstration uses those methods and apparatus which will produce the results asked for.

X Q. 49. What person or persons associated with the claimant asked you to make these tests?

A. The firm of Sheffield & Betts.

X Q. 50. With whom did you consult in the matter?

A. Mr. Cosgrove, Mr. Vaill principally, I believe.

X Q. 51. Did you consult with Mr. Waterman before making the tests?

A. Well, I believe I told Mr. Waterman that I had made some such test. I do not recollect the nature of the conversation.

X Q. 52. Did Mr. Waterman offer any suggestions to you as to the nature or character of the test?

A. Not that I recollect.

X Q. 53. Did any of these gentlemen inform you of the purpose of making the tests?

A. I was informed that the purpose of the tests was to show that the two-electrode so-called high vacuum or hard tube could oscillate.

X Q. 54. And it never occurred to you to employ a two-electrode hard vacuum tube in the circuit shown on page 87 of Claimant's Exhibit No. 171, did it?

A. I am not able to say whether or not it occurred to me, but I chose the particular circuit which I demonstrated yesterday.

X Q. 55. Did not any of the gentlemen associated with the claimant with whom you consulted prior to making your tests advise you that the defendant had challenged the validity of the alleged demonstration before Judge Mayer?

A. I have no recollection of being informed that the validity of these tests was challenged.

X Q. 56. Did they not inform you that the defendant had asserted that the two-electrode tube is inherently incapable of amplification or oscillation?

A. I believe I was informed that the defendant had asserted that the two-electrode hard vacuum tube was incapable of oscillation or amplification.

X Q. 57. Was not the matter of the alleged demonstration before Judge Mayer referred to in any of these conferences or consultations prior to making your tests here?

A. Yes, I believe reference was made to it.

X Q. 58. Did not any of these gentlemen ask you if you could make a two-electrode hard vacuum tube amplify or oscillate in a circuit like that shown on page 87 of Claimant's Exhibit No. 171?

A. If they did I do not recollect it. Certainly it left no impression on my mind.

X Q. 59. The tube or tubes which you demonstrated before Judge Mayer were not hard vacuum tubes, were they?

A. They were tubes, as I recollect it, of varying vacua. I do not think any of them were of the highest obtainable vacuum.

X Q. 60. Do you know of about what order of vacuum they were?

A. No, I do not.

X Q. 61. So far as you know, were any special pains taken to secure any special degree of vacuum with the tubes employed before Judge Mayer?

A. Yes, I know that they were intended to be as high a [fol. 1201] vacuum as we were able to get at the particular time the tubes were made.

X Q. 62. At that time the degree of vacuum attainable was quite different from that in the modern hard vacuum tube, was it not?

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A. I hardly think that is quite right. The order of vacuum obtainable today was obtainable many years ago, but the process of obtaining it had not been reduced to convenient commercial forms.

X Q. 63. Well, what order of vacuum is present in the tubes which you tested here yesterday?

A. That I am not able to tell you from any measurements, except that I can state, as I did in my direct examination, that they were made under instructions to produce

a present-day commercial high vacuum, that is to say, to produce a tube which would be, in the language of the art, a hard tube.

X Q. 64. Well, what order of vacuum would that be?

A. Well, that calls for figures which ordinarily I do not carry in my head. My recollection is something like ten to the minus five or six millimeters, but I am speaking there from recollection, not having recently had occasion to refer to the figures.

X Q. 65. Compared with that what was the order of vacuum of the tubes employed before Judge Mayer?

A. That I am unable to say, as no measurements were made on those tubes that I have any recollection of.

X Q. 66. What was the order of vacuum of the commercial tubes of that day?

A. That was a rather variable quantity. Commercial tubes were not numerous at that time. I recollect some which would be called soft tubes in the language of today; there were others to my knowledge which had very high vacua, I should say quite equal to anything that is used today.

X Q. 67. Can you undertake to give any figures as to the approximate degree of vacuum in the tubes demonstrated before Judge Mayer?

A. At the present moment I am not able to undertake to give any such figures.

X Q. 68. They were, however, tubes in which there was some residual gas present were they not?

A. That, of course, is true of any tube, even the highest vacuum obtainable today.

X Q. 69. Well, they had more residual gas in them than the tubes which you have demonstrated here, did they not?

A. I would suppose that they did have, although I made no measurements of the vacuum.

X Q. 70. Referring to your apparatus Exhibit No. 224, what is the voltage of the battery indicated in your sketch Exhibit No. 225?

A. Approximately 180 volts.

X Q. 71. What is the voltage of the battery h?

A. Approximately six volts.

X Q. 72. And how much current passed through the filament b?

A. That I don't really know. It could be determined by inserting an instrument and measuring it.

X Q. 73. What is the capacity of the storage battery h?

A. I should guess that it was about 80 ampere hours.

X Q. 74. Will you measure by measuring instruments if [fol. 1202] you can the voltage and amperage of the filament current employed by you in your demonstration of this Exhibit 224?

(Some instruments are produced.)

A. (Applying the instruments to the exhibit in question.) The voltage of battery p is shown by the Weston voltmeter to be 181 volt⁵. The current in the filament b is shown by the Weston ammeter to be 1.25 amperes. The voltage across the filament is shown to be 4.1.

X Q. 75. What is the distance between the plate c and the filament a in the tube No. 665 employed in this Exhibit 225?

A. Approximately three-quarters of an inch.

X Q. 76. What is the distance between the filament and the plate in each of the tubes 624, 663, 642 and 644 employed in the Exhibit 227?

A. The space between electrodes in tubes 663, 642, and 644 is approximately one-half inch; in tube 624 approximately one-quarter inch.

X Q. 77. Were these tubes made under your supervision?

A. Not directly, no; I specified the distance between the elements and the order of vacuum. That was all.

X Q. 78. Who made the tubes?

A. I am informed that the Westinghouse Lamp Company made them.

X Q. Who gave them to you?

A. Messrs. Sheffield & Betts.

X Q. 80. With whom did you place the order for the tubes?

A. Well, I did not place the order; I simply told Sheffield & Betts the sort of tubes to get.

X Q. 81. Did you give them this information orally or in writing?

A. Orally.

X Q. 82. Did you give them any written specifications as to the character of the tubes?

A. None whatever.

X Q. 83. What information or specification did you give them as to the order of vacuum?

A. That the tubes should be exhausted in just the same way, same process, and the same order of vacuum as is used in the modern hard three-electrode tube.

X Q. 84. And what specifications did you give them as to the distance of separation between the plate and filament?

A. I specified those distances which I have already mentioned as being found in the tubes in the demonstration.

X Q. 85. This was done orally, was it?

A. Yes.

X Q. 86. How many tubes did you ask for?

A. I do not recollect; in fact, I am not sure that I specified the number.

X Q. 87. How many did you get?

A. That I do not recollect, except that I think I had something like a dozen or a half dozen,—a half dozen I guess, and some of them were found not to be hard.

X Q. 88. Have you any others left over?

A. I don't know; I haven't any. I haven't paid any particular attention to those I was not using.

X Q. 89. Are they around this laboratory here, if you know?

A. Well, I don't know, no. I have not seen them for some time.

X Q. 90. Is this place where these tests are being made your laboratory?

A. No, it is not.

X Q. 91. Whose is it, do you know?

A. I believe it is Mr. John V. L. Hogan's.

X Q. 92. And he furnished you with the apparatus which you have employed?

[fol. 1203] A. I believe part of it was furnished by this laboratory and part of it by the R. C. A. Laboratory.

X Q. 93. What is the R. C. A. Laboratory?

A. That is a laboratory of the Radio Corporation at Van Cortlandt Park.

X Q. 94. Will you inquire and see if there are any more of these tubes such as you have used in this demonstration available?

A. I will do so.

X Q. 95. How long will it take you to find out?

A. That I do not know. I will inquire as soon as we are through with the cross-examination.

X Q. 96. Can you make the inquiry now?

(Witness goes into the next room.)

• • • • •

A. I have made the inquiry, and there are six tubes which I produce in addition to those used in the demonstration (placing the tubes before counsel).

X Q. 97. These were produced from the drawer of a desk about fifteen feet away, were they not?

A. Even closer than that.

X Q. 98. Were any of these tubes which you have just produced employed by you in these circuits Exhibits 224 and 226?

A. I believe they were all tested.

• • • • •

X Q. 99. And from the tests of all of the tubes you selected the ones best available for your purposes, did you not?

A. I selected five tubes, as some of those tested were defective.

X Q. 100. I note that these tubes which you have just produced here are numbered 622, 623, 645, 668, 6213 and 6414. That is correct, is it not (showing the tubes to the witness)?

A. Yes.

X Q. 101. What do these numbers signify?

A. As far as I know merely identification marks.

X Q. 102. Who placed the numbers on the tubes?

A. I do not know.

X Q. 103. Are these tubes all supposed to have the same degree of separation between the plate and the filament?

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A. Obviously they have not; as can be seen by an inspection, the separation is different in the different tubes.

X Q. 104. When you gave your specifications to Messrs. Sheffield & Betts, did you give them any special degree of separation or did you ask them to give you a variety of different spacings?

A. I asked for three different spacings, as I recollect it, one-quarter inch, one-half inch and three-quarter inch.

X Q. 105. Why did you require different degrees of spacing between the plate and the filament?

A. I knew from previous experience that there were differences in the results obtainable with different spacings, and so I had several spacings in order to select those suitable for the purpose. It has been some years since I had previously worked with these tubes, and my recollection of just what was the best spacing was somewhat uncertain.

X Q. 106. Will you explain in as great detail as possible why you expected different results to be attained by reason of different degrees of spacing between the plate and filament, what the different results are and all of the considerations affected by the degree of spacing?

A. The answer to that is rather simple: I simply had found from previous experience that a spacing made a difference in the way in which a tube worked. I therefore simply followed my experience in having the present tubes made.

X Q. 107. What difference does it make whether the spacing between the plate and filament in these tubes is large or small?

A. Well, if it is too small it is difficult to control the electron stream with an exterior electrostatic field. If it is too great the internal resistance of the tubes becomes very high and it is difficult to get any energy out of the tube. In general, these are characteristic effects which are found in the construction of valves of either two or three-electrode type, and in the case of the three-electrode type or tube many years of work have been consumed in determining the best spacing of the electrodes, their size, etc.

Mr. Edwards: Defendant's counsel asks to have the six tubes produced by the witness marked for identification "Defendant's Exhibit U-6".

(The six tubes were so marked.)

X Q. 108. What difference does it make whether or not the tube is located close to the condenser R in Exhibit 225 or close to the coils L₁, L₂, L₃ and L₄ in Exhibit 227?

A. As I explained in my direct examination yesterday, the location of the two-electrode vacuum tube in the vicinity of either the condenser R or coils L₁, etc., permits the electrostatic field which exists on these elements to affect the electron stream which flows between the cold electrode and the hot electrode in the two-electrode vacuum valve.

X Q. 109. Which has the greatest effect upon the electron stream, locating the tube close to the condenser as in Exhibit 225, or locating the tube close to the induction coils as in Exhibit 227?

A. So far as I know, there is no difference.

X Q. 110. In both cases the electrostatic field operates upon the electron stream between the plate and the filament in the same way?

A. As I understand it, yes.

X Q. 111. Why is the degree of separation greatest in the tube employed in Exhibit 225?

A. I believe that that is merely a matter of chance, as I recollect it.

X Q. 112. I believe you said the space between the plate and filament in the detector tube No. 624 in Exhibit 226 was about a quarter of an inch, did you not?

A. Yes, that is right.

X Q. 113. And the other tubes about half an inch?

A. Yes.

X Q. 114. What is the reason for using the smaller separation in the detector tube and the larger separation in the amplifier tube?

A. The smaller separation is a little better as a detector. The larger separation in the amplifier tube is considerably better than the smaller separation.

[fol. 1205] X Q. 115. In what way is the smaller separation better in the detector tube and the larger separation better in the amplifier tubes?

A. The detection with the smaller separation is a little better, that is to say, the tube is a little more sensitive. The amplification with the larger spacing is better than with the smaller spacing.

X Q. 116. Why or in what way is it better?

A. Well, the real reason why it is better I expect would require a rather elaborate research to determine. I merely know that it is better from my experimental experience.

X Q. 117. Can you not explain in what way it is better?

A. Not in a way that would be satisfactory to me. That happens to be the sort of thing that I require rather exhaustive investigation for before I am satisfied as to the exact mechanism by which it works. In a general way, I can say that the electrostatic field affects the electron stream, and that when the spacing is of the order of that

used in the amplifier and in the oscillator it appears to be unable to so affect the electron stream as to produce amplification and oscillation.

X Q. 118. In your demonstration of Exhibit 226, did you use approximately the same voltage between the plate and filament as in your demonstration of Exhibit 224?

A. Yes, I did.

X Q. 119. That is to say, about 180 volts?

A. Correct.

X Q. 120. In this case, however, I note from the drawing that the filament battery is marked 12 volts. Was that larger voltage used in the set Exhibit 226?

A. That was simply because the rheostats we happened to use and shown in the drawing Exhibit No. 227 as R_1 , R_2 , R_3 and R_4 were of rather high resistance.

X Q. 121. Then I take it that the voltage and amperage of the filament current used in the demonstration of set, Exhibit No. 226, was the same as that in the demonstration of set, Exhibit 224?

A. That is correct.

X Q. 122. How long have you known that a two-electrode tube could be made to oscillate?

A. I do not remember the exact date when I first made a two-electrode tube oscillate, but it is something more than twelve years ago.

X Q. 123. And since that time have you given considerable attention to studying the phenomena of oscillation by two-electrode tubes?

A. I have done considerable work with two-electrode tubes since that time, including the phenomena of oscillation.

X Q. 124. And you have taken out a number of patents, have you not, designed to make two-electrode tubes amplify or oscillate?

A. I have taken out a number of patents on a tube which had two internal electrodes and one external electrode.

X Q. 125. Do you regard that kind of a tube as a two-electrode tube or a three-electrode tube?

A. Well, that is largely a matter of language, nomenclature, but if such a tube had an exterior electrode made to go around it as was the case of the tubes illustrated in my patents referred to, I personally would consider it a three-electrode tube.

X Q. 126. Are you the Roy A. Weagant who applied for and obtained United States Letters Patent No. 1,252,520, granted January 8, 1918; No. 1,278,535, granted September 10, 1918; No. 1,289,981, granted December 31, 1918; No. 1,306,208, granted June 10, 1919; No. 1,342,399, granted June 1, 1920, and No. 1,380,206 granted May 31, 1921? [fol. 1206] A. Yes.

X Q. 127. Do you regard the tubes shown in these patents, particularly 1,252,520, 1,278,535, 1,289,981, 1,342,399 and 1,380,206 as operating in those patents as a two-electrode or three-electrode tube?

A. The answer to that depends largely on the significance and meaning given to the word "electrode". The patents to which you have referred, with the exception of No. 1,342,399, show three separate conducting elements, two of which are inside of the tube and one of which is outside. As the word is ordinarily used, "electrode" would apply only to the two elements inside of the tube. In the case of No. 1,342,399 there are two outside separate conducting elements, so that this particular arrangement has four elements, two of which are internal, and, under the usual significance of the word, would be known as the electrodes. The outside elements I have been in the habit of calling "shield", although that word is not particularly appropriate.

X Q. 128. Do you consider that the tubes in Patents Nos. 1,252,520, 1,278,535 and 1,289,981, for example, are operating as two-electrode tubes or three-electrode tubes?

A. Giving to the word "electrode" the significance that I have just mentioned, namely, that of the essential separate conducting elements within the tube, I would call them two electrode tubes.

X Q. 129. But you would add, would you not, that in order to attain the operation set forth in the patent you must employ a third element, namely, the element k, outside the tube?

A. For the operation of the tube as illustrated in these patents, the exterior element illustrated therein is necessary.

X Q. 130. Is it necessary that that element k shall extend entirely around the outside of the tube?

A. Not necessary but preferable.

X Q. 131. Do you consider that you could have attained amplification or oscillation or both in either your apparatus

Exhibit 224 or Exhibit 226 without locating either the condenser R in Exhibit 225 or the inductance in Exhibit 227 adjacent to the tubes?

A. As I stated in my direct, it is necessary to locate the tube adjacent to either the coil or the condenser.

X Q. 132. And it is a fact, is it not, that the coil or the condenser performs a function analogous to the function of a grid in an ordinary three-electrode vacuum tube?

A. I think I would put that the other way around by saying that the grid performs in a way which is analogous to the performance of the two-electrode tube which I have demonstrated, but it does it in a more complete and more perfect manner due to the location of the grid within the tube and directly in the path of the electron stream. Both devices function as the result of the control by an electrostatic field of the electron stream flowing within the tube. In the demonstration of the two-electrode tube which I showed, the means of getting the electric field where it could control the electron stream was the arrangement of the apparatus; that is to say, I simply put the tube near a suitable electric field and is operated. Now, in the case of the grid which is used in the three-electrode tube this electric field is on the grid itself and the grid is right in the midst of the electron stream. Consequently, it is so located as to [fol. 1207] produce the greatest possible effect. In one case the result is accomplished by the use of an additional electrode in the tube itself; in the other case merely by a suitable association of the ordinary parts constituting the radio receiver.

X Q. 133. Then it is a fact, is it not, that in your demonstrations, by reason of the location of the condenser or inductance adjacent to the tube you created an electrostatic field which operated upon the electron stream between the plate and filament of the tube in substantially the same way, although perhaps not in degree, as the grid of an ordinary three-electrode tube operates upon the electron stream between the plate and filament of that tube?

A. I intended in my last answer to make clear the fact that in both cases the electric field was the controlling element which acted upon the electron stream; that in the case of the three-electrode tube this field was brought right inside of the tube itself, while in the case of the two-electrode tube which I demonstrated the field was adjacent to the tube but outside of it.

X Q. 134. What would have been the effect or the result if in your demonstration you had employed tubes in which the plate element comprised a continuous cylinder surrounding the filament?

A. That seems to me to be somewhat of a speculation. I do not think I would care to answer what would happen under those circumstances, unless I tried it. Long experience in this particular art has taught me that the way to find out what will happen under a given set of circumstances is to make experiments.

X Q. 135. Based upon your long experience, have you no opinion upon this subject?

* * * * *

A. As a matter of opinion and purely as a matter of speculation, I believe that I could construct a tube with a cylindrical plate surrounding a filament which would operate in the manner of the tubes demonstrated in the test.

X Q. 136. To do that I take it you would have to increase the strength of the electrostatic field, would you not?

* * * * *

A. But that question as it stands is not answerable, because I do not know what electric field you refer to.

X Q. 137. I am referring to the electrostatic field which you created by the condenser in the one case and the inductance in the other case for the purpose of controlling the electron stream between plate and filament.

A. In my answer to the question before the last one, where I expressed my opinion as to what might be done, I meant that it was my opinion that a tube could be constructed in the way specified which would operate under the same conditions, circumstances, circuits, etc., as those of the tests and demonstrations which I made.

X Q. 138. You would expect that if the plate element consisted of a cylinder entirely surrounding the filament it would at least tend to shield the electron stream from the effect of the electrostatic field which you used to control the electron stream, would you not?

A. Not if you put the electrostatic field in the right place. [fol. 1208] X Q. 139. Meaning where?

A. I think I would have to illustrate that by a sketch.

X Q. 140. Please do.

A. If I may have a piece of paper. (A sheet of paper is handed to the witness, who draws thereon.) I have drawn

a very crude sketch in which, in top view, Fig. 1, a circle a represents the glass tube and circle b represents the cylindrical plate. The part of a circle c represents the filament. These same things are shown roughly in elevation in Fig. 2 by corresponding letters. A tube of the construction so shown with the electrostatic field in the vicinity of the top, in my opinion would function the same as those demonstrated the other day.

Mr. Edwards: Defendant's counsel offers this sketch in evidence, and asks that the same be marked "Defendant's Exhibit Q-6".

(The sketch was so marked.)

X Q. 141. In the case I have just referred to, by locating the electrostatic field above the tube you would, in effect, not be shielding the electron space from the electrostatic field by the plate element, would you?

A. That is correct; by locating the electrostatic field near the top of the tube the plate does not shield it.

Last Question by the Notary: Do you know of any other matter relative to this claim?

Answer: No.

Deposition Closed

[fol. 1209] Deposition of ROY A. WEAGANT, for Claimant, taken at New York, N. Y., on the 17th day of January, A. D. 1927.

Direct examination.

By Mr. Vaill:

Q. 142. Are you the same Roy A. Weagant who has heretofore testified as a fact witness during Claimant's *prima facie* proofs and as a fact witness relative to demonstrations for the two-element high vacuum valve as an oscillator?

A. I am.

Q. 143. Can you produce photographs of the apparatus which you used in demonstrating the capability of oscil-

iating and amplifying in the two-element high vacuum tube on Tuesday, December 28th, 1926, at the laboratory of Mr. John V. L. Hogan, 140 Nassau Street, New York City?

A. I can and do.

Q. 144. How did you obtain these photographs?

A. These photographs were made by a professional photographer accustomed to this sort of work, under my direction, on the day after the demonstration you have referred to.

Mr. Vaill: Claimant's counsel offers in evidence the two photographs produced by the witness, and requests that the same be marked respectively "Claimant's Exhibits Nos. 228 and 229".

(Said exhibits marked as requested.)

At the request of counsel for Claimant counsel for Defendant admits that the Bill of Complaint in the suit in the United States District Court for the Eastern District of New York, entitled Marconi Wireless Telegraph Company of America, Complainant, *versus* National Electric Signaling Company, Defendant, Case D. E. 23, for the [fol. 1210] infringement of Re-issue Patent No. 11,913 to Marconi, and Patent No. 609,154 to Lodge, was filed on May 10th, 1912.

Mr. Vaill: Counsel for Claimant offers in evidence a copy of an article by E. H. Armstrong, entitled "Operating Features of the Audion", published in the Electrical World (New York) in the issue of December 12, 1914, pages 1149-1152, which article was referred to and adopted as a part of his Opinion by Judge Julius M. Mayer in the suit of Marconi Wireless Telegraph Company of America, Plaintiff, *versus* DeForest Radio Telephone and Telegraph Company, *et al.*, Defendants, in the United States District Court for the Southern District of New York on the Fleming Patent No. 803,684, which Opinion is reported in Volume 236 of the Federal Reporter, page 942, and requests that the same be marked "Claimant's Exhibit No. 230".

(Said exhibit marked as requested.)

It is Stipulated and Agreed by and between counsel for the respective parties hereto, that should C. D. Mitchell

be called as a witness on behalf of Claimant in this case, he would testify as follows:

That he is of mature age and is employed by the Westinghouse Lamp Company at Bloomfield, New Jersey; that during the month of November, 1926, he was instructed by the Director of the Research Laboratory of the Westinghouse Lamp Company to prepare certain two-element high vacuum radio tubes for use in the suit of Marconi Wireless Telegraph Company of America *vs.* The United States; that in accordance with certain instructions he prepared such tubes; that such tubes were manufactured at the plant of the Westinghouse Lamp Company and given to him for the purpose of producing the required vacuum in such tubes before they were sealed off; that his instructions in this respect were to produce such a degree of vacuum as is now used in the modern high vacuum or "hard" three-element vacuum tubes and by the modern and usual methods now employed in exhausting such tubes; that he proceeded to exhaust said tubes so that the degree of vacuum produced in all of said tubes is the same as in present-day commercial three-electrode hard vacuum tubes known as the UX 201 A and in general said tubes have a vacuum of about ten to the minus five millimeters (10^{-5} m.m. or $1/100,000$ m.m.) of mercury in terms of barometric pressure; that the tube No. 665, forming a part of "Claimant's Exhibit No. 224", was so exhausted by him; that tubes Nos. 624, 642, 644 and 663, forming a part of "Claimant's Exhibit No. 226", were also exhausted by said method; that tubes Nos. 622, 623, 645, 668, 6213 and 6414, marked for identification as "Defendant's Exhibit P-6" at the request of Defendant's counsel, were also exhausted by the same process.

It is Also Stipulated and Agreed by and between counsel for the respective parties hereto, subject to correction should error appear, that the following letter which appears in the printed text on pages 177 and 178 of a book entitled "A Handbook of Wireless Telegraphy", by James Erskine-[fol. 1211] Murray, published by Crosby, Lockwood & Son, London, in 1907 is a substantially correct copy of a letter transmitted by J. M. Hudgins, Lieutenant U. S. Navy, on or about August 6th, 1905, from the U. S. S. Kearsarge, Bar Harbor, Maine, to the Chief of the Bureau of Equipment at Washington, D. C., through the Division Com-

mander, Second Division, and Commander-in-Chief of the North Atlantic Fleet, and that said letter was received in due course of transmission by the Chief of the Bureau of Equipment, Navy Department, Washington, D. C., to-wit:

"U. S. S. Kearsarge, 1st Rate,
Bar Harbor, Maine, *6th August 1905.*

SIR:

1. I have the honour to make the following report on the test of the Fessenden Wireless Telegraphic apparatus between the U.S.S. 'Alabama' and U.S.S. 'Illinois' on the afternoon and night of the 2nd inst., and forenoon of the 3rd.

2. The apparatus was handled, both in preparation for, and during the test by the regular ship's operators. In obedience to orders from the Commander-in-Chief, I reported on board the 'Illinois,' and observed the working of the apparatus on that ship. The test took place at sea, over clear water between the latitudes of 38° and 44° north, and longitudes of 68° and $70^{\circ} 48'$ west, and lasted from 1 P. M. of the 2nd inst. until 3:30 P. M. on the 3rd.

3. The 'Illinois' separated from the Fleet at Nantucket Shoals Lightship at 12:30 P. M., 2nd August, and steamed on a course south-west by south at a speed of twelve knots. The 'Alabama' continued with the Fleet, and steamed generally on a course north-east by north, at a speed of from ten to twelve knots. In accordance with the pre-arranged schedule, the 'Alabama' sent her position in latitude and longitude on the hour and thirty minutes, and the 'Illinois' sent hers on the fifteen and forty-five minutes.

4. Sending with a normal strength of from thirty to thirty-five amperes, fifty to sixty volts on transformer, and with a spark-gap on each side of the cooling plate of from 3/16 inch to 1/4 inch, the ships continued in easy communication with each other up to 11 P. M., at a distance of 230 miles, when the 'Alabama' asked the 'Illinois' to send stronger, increased spark-gap on 'Illinois' to 5/16 inch each side of cooling plate, and sending current to forty amperes. The 'Alabama' continued to receive up to midnight, a distance of 251 miles, after which she failed to make out any message from the 'Illinois', or even satisfactory parts of messages, until the following morning at 9:45, when she got part of the 'Illinois' position message, but was

interrupted by the Maryland and Boston Navy Yard. The distance between the two ships at that time was 267 miles. The reception on the 'Illinois' continued good, and the position of the 'Alabama' was correctly received for mid. and [fol. 1212] 12:30 P. M. The position for 12:30 was sent up to 12:45, and the distance between the two ships at 12:45 was 268 miles.—Very respectfully,

J. M. HUDGINS,
Lieutenant, U. S. Navy.

THE CHIEF OF BUREAU OF EQUIPMENT,

*Through the Division Commander, 2nd Division, and
the Commander-in-Chief, North Atlantic Fleet."*

RICHARD A. FORD,
EDWARD W. VAILL,
Counsel for Claimant.
C. V. EDWARDS,
Special Assistant to the Attorney-General.

Approved:

HERMAN J. GALLOWAY,
Assistant Attorney-General.

Q. 145. Please state your theoretical and practical experience and training in the radio art, which would tend to qualify you as an expert in such art.

A. I am an Electrical Engineer and was educated at McGill University, Montreal, Quebec, Canada, where I completed the course in Electrical Engineering in the year 1905, and I hold from this institution the Degree of Bachelor of Science. After leaving College I engaged in the usual preparatory work of a young engineer, serving in shops, drawing offices and engineering offices, and in 1908 I took up wireless telegraph work with the National Electric Signaling Company, serving under Professor Reginald A. Fessenden. I remained in the employ of this Company from 1908 until 1912, during which time I engaged in the design, development and research work of wireless telegraph apparatus. In 1912 I became an engineer in the employ of the Marconi Wireless Telegraph Company of America, and in 1915 was made Chief Engineer in charge of all of the Company's technical activities. I remained Chief Engineer of the Marconi Wireless Telegraph Company of America until the formation of the Radio Corpo-

ration of America. During this period from 1912 until 1920, I had to do with every phase of wireless telegraph work, including research, design of apparatus, manufacture of apparatus, installation and operation of apparatus. There were made under my direction during this time many thousands of radio outfits, both transmitting and receiving.

From 1920 until October, 1924, I was in the employ of the Radio Corporation of America as Consulting Engineer, and was occupied during this time with various special investigations. I am a Fellow and Charter Member of the Institute of Radio Engineers and have received from them the Morris Liebman Memorial Prize for my work in the reduction of static interference. I am also a Member of the American Institute of Electrical Engineers and the New York Electrical Society. I have published several papers in the Proceedings of the Institute of Radio Engineers. In addition to the practical work which I have done during my nineteen years' connection with radio, I have devoted a great deal of time to the theoretical study of this subject, including its mathematical and physical aspects.

Q. 146. Have you read the depositions taken by Claimant [fol. 1213] in its prima facie testimony in this case, and have you examined the exhibits referred to therein?

A. Yes, I have.

Q. 147. Have you read the depositions taken on behalf of defendant in its answering testimony herein, and have you examined the exhibits referred to in such depositions?

A. Yes, I have.

Q. 148. Have you read the fact depositions taken in Rebuttal on behalf of the Claimant herein, and have you examined the exhibits referred to in such depositions?

A. Yes, I have.

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[fol. 1214] In Tesla patents Nos. 645,576 and 649,621, "Defendant's Exhibits X-2 and U-6", we find, however, that Tesla has reduced his ideas to definite form. In patent No. 645,576, he refers to the work of William Crookes in the matter of gas conductivity, and he states, lines 10, *et seq.*:

"It has been well known heretofore that by rarefying the air inclosed in a vessel its insulating properties are impaired to such an extent that it becomes what may be con-

sidered as a true conductor, although one of admittedly very high resistance. The practical information in this regard has been derived from observations necessarily limited in their scope by the character of the apparatus or means heretofore known and the quality of the electrical effects producible thereby. Thus it has been shown by William Crookes in his classical researches, which have so far served as the chief source of knowledge of the subject, that all gases behave as excellent insulators until rarefied to a point corresponding to a barometric pressure of about seventy-five millimeters, and even at this very low pressure the discharge of a high-tension induction-coil passes through only a part of the attenuated gas in the form of a luminous thread or arc, a still further and considerable diminution of the pressure being required to render the entire mass of the gas inclosed in the vessel conducting. While this is true in every particular so long as electromotive or current impulses such as are obtainable with ordinary forms of apparatus are employed, I have found that neither the general behavior of the gases nor the known relations between electrical conductivity and barometric pressure are in conformity with these observations when impulses are used such as are producible by methods and apparatus devised by me and which have peculiar and hitherto unobserved properties and of effective electromotive forces, measuring many hundred thousands or millions of volts."

Tesla is quite evidently interested in the conductivity of gases and he brings out the fact that gases ordinarily are [fol. 1215] of very high resistance and that with usual electrical apparatus it is very difficult to get electrical currents to flow through them, but he points out in the concluding paragraph of my quotation that he has devised apparatus which, because of its ability to produce enormous electrical pressures, is able to overcome this difficulty.

Having first referred to the conductivity of gases and the fact that he has discovered means of sending electrical currents through them, he next proceeds to point out the reason why he is interested in gas conductivity, particularly gases at low pressure. This reason is that he wants to send electrical currents through the upper air strata, where its pressure, that is, the atmospheric pressure, is very low, so that the air is in the rarefied condition, under

which condition it is, as pointed out by Crookes, a conductor.

On page 2 of patent 645,576, Tesla states various facts relative to the conductivity of the atmosphere and then sums up the whole matter in lines 114 to 121, in the following statement:

"Expressed briefly, my present invention, based upon these discoveries, consists then in producing at one point an electrical pressure of such character and magnitude as to cause thereby a current to traverse elevated strata of the air between the point of generation and a distant point at which the energy is to be received and utilized."

This paragraph brings out quite clearly that Tesla's theory of operation was based on the conductivity of the upper strata of the atmosphere and that he proposed to utilize these properties to conduct electricity from one point to another. It is of interest to note in this connection the height to which Tesla expected to carry his conductive wires in order to realize the requirements of his theory of operation, and we find the following statement, line 129, page 4, of patent 645,576, to line 11, page 5, of the same patent:

"From my experiments and observations I conclude that with electromotive impulses not greatly exceeding fifteen or twenty million volts the energy of many thousands of horse-power may be transmitted over vast distances, measured by many hundreds and even thousands of miles, with terminals not more than thirty to thirty-five thousand feet above the level of the sea, and even this comparatively small elevation will be required chiefly for reasons of economy, and, if desired, it may be considerably reduced, since by such means as have been described practically any potential that is desired may be obtained, the currents through the air strata may be rendered very small, whereby the loss in the transmission may be reduced."

In order, therefore, to carry out the requirements of Tesla's theory of operation, it would be necessary to sustain a conductor some thirty to thirty-five thousand feet in the air. From my knowledge of engineering matters in general and my experience with radio, I know that no

one has as yet ever succeeded in maintaining a wire of any such length in the air, and I am quite unable to see how it could be done. It occurred to me, however, in examining the Tesla patents, that perhaps Tesla would cite some actual practical arrangement which he had used, but I [fol. 1216] find that instead of an aerial conductor thirty-five thousand feet in the air, that in his statement explaining his practical use of his invention, he refers, lines 8 to 18, page 4, to the outer end of the secondary or high tension coil A as being connected to the ground, while the free end was led to a terminal placed in the rarefied air strata through which the energy was to be transmitted, which was contained in an insulating tube of a length of fifty feet or more, within which a barometric pressure varying from about 120 to 150 millimeters was maintained by means of a mechanical suction pump. And in lines 23 to 27, that the receiving apparatus was connected to the other end of the fifty-foot tube. It therefore appears that in such practical use as Tesla himself states that he made of his apparatus, instead of conducting large currents through the upper atmosphere to distances of hundreds or thousands of miles, he merely sends his electrical energy from one end to the other of a fifty-foot tube. So far as I am aware, no one else has succeeded in effecting the transfer of electrical energy to any appreciable distance following the theory and method of Tesla. The actual results obtained under Tesla's theory and Marconi's theories form a most interesting contrast and supply the best possible means of determining their relative correctness. In the case of Tesla, conduction through a rarefied gas to a distance of a few feet; whereas, under the theories of Marconi Hertzian waves carrying intelligence through thousands of miles of space and forming today one of the great communication systems of the world.

Not only has Tesla, in his direct statements in the patents to which I have referred, set forth a theory of operation totally distinct from that of the Marconi Re-issue patent No. 11,913 but, in lines 73 to 82, page 2 of patent 649,621, he has specifically denied the usefulness of Hertzian waves for his purpose in the following words:

"It is to be noted that the phenomenon here involved in the transmission of electrical energy is one of true conduction and is not to be confounded with the phenomena

of electrical radiation which have heretofore been observed and which from the very nature and mode of propagation would render practically impossible the transmission of any appreciable amount of energy to such distances as are of practical importance."

The phenomena of radiation referred to here is, of course, the Hertzian wave phenomena employed by Marconi, and Tesla's statement shows that he failed completely to recognize its usefulness.

In the light of the foregoing facts it is my opinion that Marconi and Tesla proceeded on two totally distinct and different theories of operation; that Marconi's theory of operation depended upon Hertzian waves radiated out from the transmitting station and received by a receiver at a distant point, while Tesla's theory of operation depended upon the conductivity of the upper strata of the earth's atmosphere and the actual conduction of electricity from one point to another through this conducting atmosphere. One theory, that of Marconi, proven by enormous and ever increasing practical use, the other theory, that of Tesla, never reduced to practice even by its originator.

Q. 155. Do you find shown or described in the Tesla book of Martin, "Defendant's Exhibit B-4", any apparatus as [fol. 1217] shown in Loftin's sketch A (Defendant's Exhibit R-4), referred to by Mr. Mauborgne in answer to Q. 7 of his deposition, on Printed Record page 1210. Please give reasons for your answer.

A. I fail to find any such association of apparatus as is shown in Loftin Sketch A opposite page 957 of the Printed Record. I fail not only to find the association of elements shown in Loftin sketch A considered in the Martin book, but, on the contrary, I find statements which show with great distinctness that no such association was contemplated.

On page 348 of the Martin book of Tesla, "Defendant's Exhibit B-4", Fig. 185, is shown the arrangement which I have already discussed in answer to the previous question, and the comment relative to it on page 349, which I have quoted in my last answer, shows very clearly that Tesla did not recognize any possibilities of associating any apparatus with which he was familiar with the scheme which he outlines on page 348. Mr. Loftin in his answer to Q. 2 in the middle of Printed Record page 957, states:

"It is reasonable to associate the system in Figure 185 (of the Martin book) with any one of the numerous systems illustrated in Figure 165 for producing high-frequency currents."

The reasonableness or otherwise of this association seems to me to be determined by what Tesla himself did and in the Martin book, "Defendant's Exhibit B-4", as previously pointed out, there is not only no such association as shown in Loftin sketch A but the very definite statement previously referred to on page 349, that Tesla lacked at that time any knowledge or ideas which would lead him to make the association.

In drawing the sketch Mr. Loftin has taken one element of Fig. 165, viz., that next to the bottom of page 303 of "Defendant's Exhibit B-4" and one of the generators G. The elevated conductor system he has taken from Fig. 185, apparently, and inserted therein an inductance coil S-1 (Loftin Sketch A), which inductance is not to be found in Fig. 165.

Mr. Loftin, in his answer to Q. 2, states, page 958 of the Printed Record, middle paragraph:

"While Tesla did not specifically illustrate a switch generally known as an operator's key, for making dots and dashes in the Morse code, I consider that the insertion of such a key in a system was decidedly obvious to those skilled in the art at that time."

As an inventor of many years' experience, I have had a great deal to do with the question of whether or not a thing which has actually been done and accomplished is obvious, and in practically all of such instances I have concluded that if a thing were obvious, it would have been done. In the consideration, therefore, of the present question, I have no hesitation in saying that if it were reasonable to associate anything disclosed in "Defendant's Exhibit B-4" in the manner of Loftin's sketch A, that Tesla would have made such an association. That he did not do [fol. 1218] so is evident from a mere inspection of this exhibit. If it were obvious to insert a transmitting key in the place shown as S in Loftin's sketch A, and if Tesla had any purpose in so inserting this key he would have done so, but he did not. I am therefore unable to agree

with Mr. Loftin that the arrangement of Loftin sketch A is disclosed anywhere in "Defendant's Exhibit B-4."

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[fol. 1219] Q. 166. What part did you take in the case of Marconi Wireless Telegraph Company of America versus National Electrical Signaling Co., in the United States District Court for the Eastern District of New York, on Mar- [fol. 1220] coni Re-issue patent No. 11,913, and Lodge patent No. 609,154?

A. I served as a fact witness in that case and I assisted Mr. Waterman in the making of numerous experiments with the apparatus of these patents. I also spent considerable time in Court during the taking of the testimony.

Q. 167. Will you please state in what other suits in the United States Courts involving wireless or radio patents you have testified on technical matters as a Radio Engineer?

A. I have testified as a Radio Engineer in the following cases:

1. Marconi *vs.* Atlantic Communication Company, on Marconi patent No. 763,772, and on Lodge patent No. 609,154 in the Eastern District of New York.

2. Marconi *vs.* Atlantic Communication Company, Southern District of New York, on Fleming patent No. 803,684.

3. Marconi *vs.* DeForest Radio Telephone and Telegraph Company, Southern District of New York, on Fleming patent No. 803,684.

4. Marconi *vs.* Kilbourne & Clark Manufacturing Company, United States District Court, Western District of Washington, Northern Division, Ninth Circuit, on Lodge patent No. 609,154 and Marconi patent No. 763,772.

5. Marconi *vs.* National Electric Signaling Company: Second Circuit, Marconi patent No. 763,772, Marconi Re-issue patent No. 11,913, on Lodge patent No. 609,154 and Marconi patent No. 627,650, U. S. District Court, New York, Eastern Division.

6. Marconi *vs.* United States, Court of Claims, in the present suit, No. 33,642.

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[fol. 1221] Q. 182. Have you read, and do you understand, the invention described in Marconi patent No. 763,772 in

suit, and particularly, as claimed in claims 1, 2, 3, 6, 8, 10, 11, 12, 13, 14, 16, 17, 18, 19 and 20?

A. I have read the patent and believe that I understand the disclosures thereof, and the claims specified.

Q. 83. Please give your understanding of the disclosures of the invention of Marconi patent No. 763,772 as to the claims mentioned in the last question, and state the position and value of the invention in the art at the date of the application, and subsequently thereto, down to the present time. Please give your reasons therefor in contradistinction to reasons advanced by Mr. Loftin, tending to indicate a lack of valuable advance over the prior art.

A. Marconi patent No. 763,772 discloses for the first time in a radio-communication system a transmitter having two tuned circuits, one of which constitutes a reservoir for the [fol. 1222] storage of energy, while the other constitutes a good radiator of this energy, and both circuits are in tune one with the other, that is to say, have the same natural time-period. It also discloses a receiving system consisting of an open antenna circuit, which is a good absorber of energy and a closed circuit, which is a good conservator of energy, and the tuning together of these two circuits to have the same natural time-period. Not only are the two circuits at the transmitter and the two circuits at the receiver tuned together, but all four circuits are tuned together; that is to say, have the same natural time-period.

Marconi's patent not only sets forth the above great essentials in the matter of tuning, but gives complete and minute details for the construction of the apparatus necessary to bring about the result desired.

In the antenna circuits of both the transmitter and the receiver there is shown a variable inductance, which provides the simple and effective means of tuning the antenna circuit.

In the closed reservoir circuit of the transmitter, consisting of the condenser c and inductance d , and a spark-gap C, the condenser c is made variable, as will be seen by reference to lines 88 to 94, page 1 of the patent, and this variable construction is a simple and effective means for bringing the closed reservoir circuit into tune with the open radiating circuit.

In the receiving circuit of Fig. 2 the closed circuit, consisting of inductance g^2 , inductance j^2 , condenser j' and inductance g^2 and condenser h' is provided with simple and

effective means for tuning the closed circuit to the open circuit in the form of the inductances g^2 .

The arrow shown in the diagram Fig. 2 resting on these coils is the conventional indication of variability, and it will be noted that in the specification, page 2, lines 104 and 105, that the coils g^2 are referred to as variable inductances.

Marconi in this patent has not only set forth a great fundamental principle, accompanied by complete necessary wiring diagrams and electrical specifications, but he has also given minute details of the actual construction of the parts involved as, for instance, page 3, line 25, and continuing on through the following page. The completeness of the disclosure of this Marconi patent is very impressive, as it is a record of work actually done, rather than an exposition of a mere speculation or hope.

That the data disclosed by this patent is of such a nature as to enable one skilled in the art to actually duplicate the results of Marconi, is a fact which I know as the result of having constructed and tested, some ten or twelve years ago, the actual arrangements of this patent, which were found to work as described.

In order to make clear the significance of Marconi's patent No. 763,772, I will briefly point out the three great steps in the art of radio-communication which made possible all of the development which has since taken place. The first step was, of course, that disclosed in the Re-issue patent No. 11,913, with which patent radio began. As is always the case in a new art, the initial step which brings it into being is crude and full of imperfections, and so we find that in Marconi's first step his performance was limited in two important respects. He disclosed tuning between the antenna systems, but, due to the inclusion therein [fol. 1223] of the spark-gap at the transmitter and the coherer at the receiver, and the lack of adjustable tuning means, the degree of tuning or selectivity possible was, in the light of present-day standards, poor. Only a small amount of power could be used, since increasing power meant increasing spark-length and, therefore, antenna voltage, and the permissible limit in this respect is reached before any considerable power is used.

Lodge with his variably-acting inductance coil, provided the next vital improvement and furnished a means which prolonged the oscillations at the transmitter, increased

the selectivity in the receiving circuit and provided a simple and effective means of making tuning practicable.

Both the original Marconi arrangements and the Lodge improvement were still greatly limited in two respects, due to the inclusion in the transmitting circuit of the spark-gap which, by reason of its high resistance, introduced electrical losses in the circuit with a resulting detrimental effect upon the selectivity. The amount of power which could be used in either of these arrangements was limited, due to the fact that increasing the power meant increasing the length of the spark-gap, resulting in a high voltage on the antenna and an increased resistance, due to this spark-gap. Practically these limitations operated to prevent the use of any considerable amount of power.

The next great step, therefore, was to get the spark-gap at the transmitter and the detector at the receiver out of the antenna circuit and into an associated circuit of the right sort. It is this problem which Marconi solved in his patent No. 763,772. He puts the spark-gap in an associated circuit, that is, one coupled to the antenna, and which contains a condenser, whose capacity may be, and usually is, very large compared to that of the antenna, and thus provides a reservoir circuit into which may be stored any desired amount of electrical energy. This, however, is only the first step in his solution, since having stored the energy, he must transfer it to the antenna circuit, and to do this he first provides in his closed circuit, an inductance d in Fig. 1, which is electrically associated with a second inductance d' and he then proceeds to tune the closed circuit; this tuning, plus the association of the coils, giving the complete solution of the problem of transferring the energy from the closed circuit to the open radiating circuit.

This step was one of tremendous consequence, and is the thing which distinguishes the Marconi patent No. 763,772 from everything which preceded it. In Marconi's solution of the problem at the receiving station of getting the detector effectively and efficiently out of the antenna circuit, Marconi employs the same idea, and puts it in a closed tuned local circuit, and then he proceeds to make the complete receiving system, viz., antenna circuit and detector circuit in tune with the complete transmitting circuit, viz., the antenna circuit and the closed circuit.

This great step of Marconi's was of such fundamental importance that it has been an inherent part of nearly every radio communication system up to the present time. Due to the employment of the closed tuned reservoir circuit it has been possible to employ great powers, resulting in radio communication over thousands of miles, and due to the removal of the spark-gap from the antenna system at [fol. 1224] the transmitter and the detector from the antenna system at the receiver, and the tuning between all four circuits, a tremendous improvement in selectivity was brought about, which latter improvement made possible the working of a great number of radio stations without interference with each other.

It is of interest to note also, at this point, that so vital and fundamental was this step of Marconi's that although endless efforts have been made, to my own knowledge, for many years, to find substitutes for it, none of these methods have met with success.

Q. 184. Will you please refer to the deposition of Mr. Loftin, beginning with the last paragraph on page 1023 of the Printed Record, and state whether his explanation of the action during the transfer of alternating current energy from one circuit to another, as generally understood in the electrical art, accords with your knowledge and experience in that matter?

A. Mr. Loftin's statement is quite incorrect. If two or more circuits are associated together and are acted upon by an alternating current, except for an instant after the closing of the switch, there is only a single frequency existing in these circuits. Mr. Loftin's statements apply only to the case of circuits in which a spark-gap or other means exists, which causes them to oscillate and give rise to what are known as "free oscillations".

Q. 185. What comment have you to make on Mr. Loftin's statement in the paragraph beginning on page 1024 of the Printed Record, that in the Marconi 4-circuit tuning apparatus of patent No. 763,772 the control of the development of the coupling frequencies is "entirely through the degree of interlinkage"?

A. I disagree with Mr. Loftin's statement, for the simple reason that he has omitted to consider an electrical element, which is vital and controlling equally with the coupling in the matter of the production of two frequencies and that is, the quantity known as "resistance". If the re-

sistance of the circuits is sufficiently high, relatively close coupling may be applied, without giving rise to the usual indications of two or more frequencies.

Q. 186. Will you please consider the testimony of Mr. Loftin on the lower portion of page 1027 of the Printed Record, regarding what he considers to be the amount of coupling indicated in Marconi patent No. 763,772 and state whether or not you agree with him in his statements; if not, please give your reasons.

A. It seems to me that Mr. Loftin's statement is predicated on a lot of inference and not on any substantial basis. Mr. Marconi, in his patent 763,772, has given very complete details relative to his circuits, and while, in his specification, he nowhere says anything about coupling, these details are sufficient to enable one skilled in the art to find out, either by calculation, or by construction and measurement, just what order of coupling he did have in mind.

Mr. Waterman, in Volume I, page 152, in the Kilbourne & Clark case, has testified that the couplings between the circuits in Marconi patent No. 763,772 varied from five to nineteen and one-half per cent., according to his calculations. It so happens that I assisted Mr. Waterman in the making of these calculations and also in the making of some actual measurements, and my recollection is very clear that Marconi's actual arrangements disclosed a wide variety of couplings. To my mind, what Mr. Marconi actually disclosed [fol. 1225] closed in the actual work which he did is the only real evidence of what his ideas were in this matter of coupling, and this evidence is that he proposed to use and did use, a wide variety of couplings.

From the engineering standpoint, it is inconceivable that he should have done otherwise, because the degree of coupling, that is to say, the amount of the association between his circuits, is a thing which can only be found by trial, and varies widely with different circumstances.

It is my opinion, therefore, that Mr. Loftin's conclusion that the Marconi patent 763,772 either discloses or implies any particular degree of coupling, is entirely at variance with the facts disclosed by the patent itself, since the actual values vary from some five per cent., which is a loose coupling, to nineteen and one-half per cent., which is about

as close a coupling as is ever employed in any radio transmitter or receiver.

I note that Mr. Loftin has referred to the particular way in which coil d is drawn with the loop away from coil d' , as indicating a loose association or coupling between these circuits and I wish to point out that this Fig. 1 is purely a wiring diagram and indicates nothing whatsoever as to the matter of coupling. Furthermore, he has stated that because only a single turn was employed in the closed circuit, as illustrated in the diagram Fig. 1, and also in constructional details as d Fig. 4 that this was an indication of loose coupling. In his statement he has neglected to point out that this single turn is the entire inductance of the closed circuit, also as shown in Fig. 4, that it was physically arranged very close to coil d' , from which it follows that the coupling between the two circuits may be very close. Under these circumstances the closeness or looseness of the coupling will depend upon the amount of the coil g' which is included in the antenna circuit. If the antenna f is of such a size that for the given wave length only a few turns of g are included, the coupling will be close; or, if many turns are included, it may be loose; consequently, inferences from the diagram are without significance, without other practical information.

Q. 188. Please refer to the last paragraph beginning on page 1028 of the Printed Record and continuing on page 1029, including the first seven lines thereof, and state whether or not you consider Mr. Loftin's consideration of the questions of conductivity and resistance are in accordance with the facts relating to such matters.

A. I do not agree with Mr. Loftin's statements relative to the action of the spark-gap in the Marconi patent 763,772 and I note furthermore that he has used the word "low" in conductivity where he evidently meant "high" and the word "closed" where evidently he meant "opened". Unless these words are altered in the way indicated above, his statements at the bottom of Printed Record page 1028 and the top of page 1029 are meaningless.

Assuming that these changes are made in the wording, I then disagree with Mr. Loftin's statements as to the way in which the spark-gap of the said Marconi patent should function. This is the means which Marconi describes for instance, claim 1, as the means which automatically causes oscillations of the desired frequency. In order that it may

do this, it must have, first of all, at high and practically infinite resistance until it breaks down and it must also have the property of automatically restoring its resistance [fol. 1226] after it has broken down, and after the oscillations have ceased to exist in the closed circuit and have been transferred to the secondary circuit, that is, the antenna circuit. Just how long the gap shall remain conducting is nowhere specified in the Marconi patent, and Mr. Marconi certainly does not state that the gap must "remain high in conductivity for a long time and not open too soon to stop the flow of oscillations", as Mr. Loftin states. He does, however, show constructions of such nature that widely varying couplings exist and the length of time which the spark-gap remains active depends upon the coupling; that is, if the coupling is close to the energy is rapidly transferred and the spark gap should stop working. If the coupling is loose, the oscillations last for a longer time in the closed circuit, and the spark-gap would remain active until, as before, all the energy is transferred to the antenna circuit.

Mr. Marconi, in his patent No. 763,772, does not say anything about maintaining the oscillations for a long time in the closed circuit, but merely refers to this circuit as a persistent oscillator in contradistinction to the open antenna circuit, which is a good radiator. What he really did mean in the matter of the persistency of the oscillations, is shown by the construction which he adopts, and that is that he really didn't care how many oscillations there were in the closed circuit, so long as there were enough to get the energy out of this circuit into the antenna circuit. The very fact that Mr. Marconi has not specified in his patent any particular number of oscillations, or any particular degree of coupling is, to my mind, one of the best illustrations to be found in his work, of Mr. Marconi's great practical knowledge and experience. He recognized that these quantities were variable depending on all sorts of circumstances incident to the design of the apparatus and its use, and he knew that these were best determined by actual experiment and use, and he did not handicap the user and designer by arbitrarily specifying these quantities, but rather laid down the fundamental principles, viz., the tuned reservoir circuit and the tuned radiating circuit, and, in addition, gave practical examples of the carrying out of these principles.

Q. 189. Considering further the subject-matter involved in your last answer and the quotation by Mr. Loftin on page 1033 of the Printed Record from lines 18 to 20, page 2 of the specification of the Marconi patent in suit, which is as follows:

"electrical oscillations are set up in the circuit which persist or are maintained for a long time—in the primary circuit * * *"

will you please state what is your understanding of what Mr. Marconi meant by the use of the term "persistent oscillator"?

A. My understanding of the meaning of the term "persistent oscillator" is very different from that of Mr. Loftin, and it is particularly different in so far as its use by Mr. Marconi in the explanation of his invention is concerned.

Patent No. 763,772, lines 12 to 24, inclusive, page 2, states:

"By experiments have demonstrated that the best results are obtained at the transmitting-station when I use a persistent oscillator—an electrical circuit of such a character that if electromotive force is suddenly applied to it and the current then cut off, electrical oscillations are set up in the circuit which persist or are maintained for a long [fol. 1227] time in the primary circuit and use a good radiator—i. e., an electrical circuit which very quickly imparts the energy of electrical oscillations to the surrounding ether in the form of waves—in the secondary circuit."

This statement is a perfectly clear specification as to the type, form or nature of the circuit which he has in mind for his closed circuit, and an equally clear description of the open or radiating circuit. This description of the closed circuit refers to its characteristics when taken by itself, but it says nothing about what takes place in such a circuit when it is coupled to some associated circuit, such as the antenna circuit, which extracts energy from it. There is no inference in this statement such as Mr. Loftin has drawn, that when coupled to another circuit, the oscillations therein must persist or be maintained for a long time and, furthermore, no such requirement is anywhere stated in the Marconi patent 763,772, or is found in practice. As a matter of fact, due to the coupling existing in certain of Mr. Mar-

coni's structures only a very few oscillations could possibly exist in the closed circuit.

Mr. Loftin has extended his inferences drawn from the statement quoted from the patent to the point of determining the nature of the spark-gap, an inference which is totally unsupported by any statement that I can find in the patent and which, furthermore, is entirely contrary to all my practical experience.

Mr. Marconi himself says only a little about the spark-gap C of Fig. 1 of patent 763,772, lines 83 to 85, page 1:

"the spherical terminals or other contacts of a spark-producer or other electric-wave or oscillation producer."

This indicates that he proposed to allow a very wide latitude in the construction of the spark-gap and from the minute exactness with which Mr. Marconi has described the essential features of his invention, it is evident to me that had he desired a spark-gap which would keep active as long as possible, he would most certainly have said so, and told how to build it. The little he does say, however, is of exactly the opposite nature, for he refers to the spark-gap C, Fig. 1, as having "spherical terminals" which, as is well known, have considerable heat-radiating capabilities. Had he desired the use of a gap which would not cool quickly, he would have specified "pointed electrodes".

It is of interest to note in this connection that the art at this time was already familiar with types of spark-gaps which had marked cooling capabilities. For instance, there is shown in the Marconi Re-issue patent No. 11,913 a spark-gap, Fig. 2a, which consists of four spherical electrodes resulting in two spark-gaps in series, and is a construction which tends to cool the spark and cause it to go out. There is also shown in the British patent to Tesla, No. 20,981, of 1896 (Defendant's Exhibit Y-2"), Fig. 12, a type of spark-gap in which one element indicated by b , c' and c'' , rotates and the spark takes place between this rotating member and two other members, which are stationary, and are indicated by L .

This form of spark-gap has very marked cooling capabilities and is highly efficient, and has been found in practice up until quite recent years.

[fol. 1228] As a matter of practical fact, I may add to the above, that ever since radio has existed and a spark-gap

been used, the cooling of this gap and the extinguishing of the spark as quickly as possible has been recognized as a matter of great practical importance.

There is a point in connection with the language used to describe the closed circuit, which seems to me is of consequence in understanding Marconi's use of the words "persistent oscillator" and "good radiator"; expressions very often get into an art when it is new, which appear less apt than could be desired from the standpoint of later knowledge. When radio was young, the wave-lengths were very short; in some cases, as illustrated in Marconi Re-issue patent No. 11,913, a matter of inches or a few feet. When this was the case, an open radiating circuit was very non-persistent, any oscillations existing therein traveling off into space and extracting the energy so rapidly that the oscillations ceased to exist after a very few swings. The contrast between this type of circuit and the closed circuit either with or without a spark-gap, was very great, and led to the use of the language above quoted in distinguishing the two circuits, one from the other.

As radio developed, the wave-lengths used became longer and longer, until today we have them in use which are some 60,000 or 70,000 feet in length, and the result of this slow change and progress in the art has been that the open radiating circuit has become more and more persistent, due to the fact that the rate at which energy goes out into space from it diminishes very rapidly with the increase of wave-length, and the result of this fact is that the distinguishing language of the early art, when taken literally, in the matter of the number of oscillations existing in the two types of circuits, is not as apt as it formerly was, although the types of circuits and their functioning remains identical with that described by Marconi in his patent No. 763,772.

Q. 190. Referring further to the quotation which you have made in your last answer from the Marconi patent No. 763,772, will you please state your understanding of what Mr. Marconi had in mind in the use of the term "a good radiator" and its technical bearing upon the use of the term "persistent oscillator"?

A. The significance of the expression "a good radiator" in the Marconi patent is very clear. By this expression Mr. Marconi means a circuit of the sort which he has shown in Fig. 1 at the transmitter, for instance, comprising an

elevated conductor f A, inductance coils g d' and an earth connection E.

This is what is known in the language of the art as an "open circuit", one end of it being in the earth and the other end somewhere up in the air, and it has the electrical characteristic of being able to radiate out into space electrical energy in the form of electromagnetic waves. As shown by Mr. Marconi in his patent, it is associated with a closed reservoir circuit, in which the electrical energy exists, and from which the open radiating circuit must extract it, in order to make it useful in the production of electromagnetic waves. So long as the energy is in the closed circuit, it is of no particular use, and it must therefore be transferred to the open radiating circuit as rapidly as possible, in order to be useful, and that is why Mr. Marconi tunes these two circuits together. As a result of this combination of the two kinds of circuits of different characteristics, coupled and tuned together, Mr. Marconi is able to store up a large quantity of electrical energy and to rapidly and effectively [fol. 1229] send it out into space from the open radiating circuit in the form of electromagnetic waves.

Q. 191. In the next to the last paragraph on page 1034 of the Printed Record, Mr. Loftin refers to the use of cooling means in spark-gaps, and states that the art has not resorted to such means except where very large power is used. Will you please comment upon this paragraph in accordance with your experience and knowledge of the facts?

A. I disagree entirely with Mr. Loftin's statements in the matter of the cooling of the electrodes used for spark-gaps. It has been the practice of the art, within my own personal knowledge since 1908, to employ means for cooling the spark-gaps and great efforts have been directed in devising simple and effective means for accomplishing this purpose. I know, also, from my early recollection, that spark-gaps were cooled in the practice of radio prior to my entrance into this field, and I have already pointed out that both Marconi and Tesla, prior to the date of patent to Marconi No. 763,772, used spark-dischargers which involved cooling means. Practical men recognized as a result of actual experience that the cooler they could make the spark-gaps, the more efficiently the radio transmitter would work, and the testimony of Messrs. Reinhard, Lehr and

Clark in this case is illustrative of the practical employment of devices for the purpose of cooling the spark-gap.

It is impossible for me to conceive of a statement more contrary to the known facts of practical operation than that of Mr. Loftin on page 1034 of the Printed Record, were an engineer to follow out the principle outlined therein, viz., do all that was possible to keep the gap hot and maintain it for as long a time as possible, the spark-gap would not only work inefficiently, but would cease to operate at all. As previously mentioned, the spark-gap is a means which automatically causes oscillations of the desired frequency, and this it cannot do unless it cools rapidly, for the simple reason that if it becomes hot beyond a certain point the voltage of the secondary of the transformer which is connected to the spark-gap, will be short-circuited through the spark-gap and will not charge the condenser, with the result that no oscillations will be produced.

It follows, therefore, both from theoretical considerations and as a matter of practical experience that the spark-gap to work at all, must be cooled, and the more effectively it is cooled the more efficiently it will work. Had Mr. Marconi constructed a spark-gap to comply with the ideas expressed by Mr. Loftin, he would have constructed an inoperative arrangement, and this he certainly did not do.

Q. 192. Referring to Mr. Loftin's deposition, as found on pages 1035 to 1042 of the Printed Record, will you please comment upon the correctness and accuracy of the diagrams used by him and the statements made in connection with such diagrams?

A. Mr. Loftin, pages 1035 to 1042 of the Printed Record, has made a number of sketches purporting to illustrate what takes place in the circuits of a radio transmitter when one of these circuits is an open radiating circuit, and the other is a closed reservoir circuit.

Opposite page 1039, Sketch Fig. 1a shows a couple of trains of oscillations taking place at each half cycle of the alternator in the spark-gap circuit, but these appear to be incorrectly drawn as they are apparently of logarithmic [fol. 1236] form, which is the form that such an oscillation would take if in a circuit without a spark-gap, but when the circuit contains a spark-gap, due to the fact that the resistance increases as the oscillation gets smaller and smaller, the oscillations have a linear decrement and not a

logarithmic. Figs. 2 and 2a seem to be intended to illustrate what happens when two oscillating circuits are coupled together, and gives the impression that the motion of the electricity in these circuits is simultaneously of two different sorts. This, of course, is a totally incorrect impression. The correct impression would result from leaving out of Fig. 2 or Fig. 2a either the red or the green lines, and leaving in the others. The correct method of representing this action is shown on page 25 of "Claimant's Exhibit No. 219", being a pamphlet entitled "Elementary Principles of Radio Telegraphy and Telephony", published by the Signal Corps of the U. S. Army. Fig. 20 illustrates the usual sort of thing that happens when electrical circuits, such as those used for radio transmitters, are coupled closely together with an insufficiently cooled spark-gap. This is a sort of waxing and waning of the amplitude of the motion of the electricity in the two circuits.

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I note that Mr. Loftin at the bottom of page 1041 states:

"I have quoted the statement of objects of the Marconi invention from the specification of the patent in suit as being obtaining efficiency and localizing communication. From my discussion above as to the effects of tight coupling it is quite apparent that the Marconi system did not include tight coupling—that tight coupling actually prevents obtaining the stated object."

Mr. Loftin is here referring to his discussion on the same page of Fig. 2 and Fig. 2a, opposite page 1039 of the [fol. 1231] Printed Record, which I have also just referred to. Starting with this particular and incorrect hypothesis as to the objects of the Marconi invention, he argues that a tight coupling, giving rise to the sort of wave-train which is correctly illustrated in "Claimant's Exhibit No. 219", is not intended to be used in the Marconi patent. This inference, as I have already pointed out, is entirely unjustified by any disclosures of the patent and, furthermore, as has already been pointed out, the sort of wave-train shown in "Claimant's Exhibit No. 219" is not a necessary result of close coupling, since if the resistance of the antenna be high enough, very close coupling may be used without the production of the above described type of wave form.

I might also point out that while in general it is undesirable to so arrange matters in the transmitter of the Marconi system that a wave train of the form above described is produced, there is certainly nothing which prevents such use in case the operator desires to so use it, and there are occasional circumstances under which there may be some reason for such an adjustment. If a ship, for instance, happens to be working under such circumstances that it is important to get the greatest possible distance while at the same time there is no disturbance to other communications resulting therefrom, the operator may, and in practice occasionally has, closed up the coupling to the point where oscillations of two different frequencies were emitted by the antenna and, at the same time, the total power radiated was somewhat increased. Reception of such a radiation by a receiver, also closely coupled, may be efficient when considered simply from the standpoint of the distance covered, and when, for the time being, the matter of selectivity is not of consequence.

This illustration is intended merely to bring out the fact that operation of the Marconi system with close coupling and a complex form of radiation, is possible and occasionally used, but no inference should be drawn from it to the effect that such operation is either desirable or customary.

Q. 193. Referring to Mr. Loftin's sketch "H" opposite page 1043 of the Printed Record and the description applying thereto on pages 1042-1044, will you please state whether the figures of this sketch, particularly Fig. 4a, represent correctly the waves of the antenna circuit under conditions of unequal L and C in the two circuits of an open gap loosely coupled transmitter? Please give the reasons for your answer.

A. In Fig. 4a opposite page 1043 of the Printed Record, Mr. Loftin shows a curve which purports to illustrate what happens in a Marconi system with an open gap when loosely coupled. As in Figs. 2 and 2a, opposite page 1039, Mr. Loftin gives an incorrect picture of what is taking place. This incorrectness arises from the fact that the curve Fig. 4a would lead one to think that the electricity in the open radiating circuit was moving in two different ways at once, viz., in the manner shown by the blue curve of Fig. 4a, and at the same time in the manner shown by the red curve of Fig. 4a, and such an impression is quite in-

correct. If we assume that the blue curve and the red curve are correctly drawn as illustrating the individual components of the wave-train for some particular set of conditions, then the true picture of the motion of the electricity in this circuit would be obtained by adding together the vertical ordinates of these two curves.

[fol. 1232] In so far as any practical use of a Marconi transmitter is concerned, this diagram is entirely without significance, since it shows or rather, purports to show, something taking place when the antenna circuit and the closed circuit are not in tune, and this is not an adjustment prescribed by the Marconi patent No. 763,772, or employed in practice.

In Figs. 5 and 5a of page 1042 of the Printed Record are shown two curves, the former purporting to represent the motion of the electricity in the closed circuit and Fig. 5a, the motion of the electricity in the open circuit of a Marconi transmitter with a loose coupling and plain gap.

I note that Fig. 5 shows a curve which appears to decrease in accordance with the logarithmic law and, as I have previously pointed out, the decay of the oscillations in a circuit containing a spark-gap is, due to the resistance of the spark-gap, linear.

I fail to find anywhere in Mr. Loftin's testimony any technical data disclosing the usual necessary facts required, in order to plot curves of this sort, and I am therefore forced to state that they do not disclose any real facts relative to the operation of a Marconi transmitter with a loose coupling and a plain gap.

I have, at several points, referred to the decrement in a circuit containing a spark-gap as being linear, and not logarithmic, and will now refer to some work published by Dr. J. Zenneck. On page 13 of a translation of Dr. Zenneck's book entitled "Wireless Telegraphy" by A. E. Seelig, First Edition, 1915, there is a paragraph, 9, headed "Condenser Circuit with Spark Gap. Damping due to Spark".—This paragraph describes some experiments on the circuits containing a spark-gap and contains the following statement:

"* * * The amplitude curve is now no longer an exponential curve but approaches a straight line more and more as the energy absorbed by the spark exceeds the energy lost as heat."

The "exponential curve" referred to here is the logarithmic curve, the two words being alternatives and the "straight line" signifies the linear decrement which I have referred to as characteristic of circuits containing a spark gap.

It will be seen from the statements on pages 13 and 14 (Claimant's Ex. 241) of this publication that the greater the energy loss in the circuit due to the spark-gap, the more nearly the law of decay approaches a straight line.

Mr. Vaill: Counsel for claimant offers in evidence photostat copies of pages 13 and 14 of the book just referred to by the witness "Wireless Telegraphy" by Dr. J. Zenneck, First Edition, 1915, and requests that same be marked "Claimant's Exhibit No. 241".

(Said exhibit marked as requested.)

Q. 194. At the top of page 1045 of the Printed Record, and in answer to Q. 22 of Mr. Loftin's deposition, beginning on page 1052, Mr. Loftin states that in the apparatus of the Marconi patent the desired result is obtained in one way by

"causing the oscillations in the lateral circuit to persist or be maintained for a long time—that is, having provided for [6d, 1233] conserving its energy not to cease slowly feeding energy to the antenna circuit unnecessarily early."

Please state to what extent you agree or disagree with him, and give your reasons for your answer.

A. I do not, of course, agree with Mr. Loftin's statements to which you have referred.

His statement at the top of page 1045 is simply another statement by him of his particular and incorrect picture of the requirements, operation, and general functioning of the apparatus and system of Marconi patent No. 763, 772. Mr. Loftin's statement is divided into five parts, and he says that Marconi's result is obtained first "by creating oscillations in a lateral circuit". Mr. Loftin uses the word "lateral" in place of the more usual word "local", as describing the closed reservoir circuit of the transmitter, and he is correct in stating that the production of oscillations in this circuit is one of the necessities of the Marconi system.

Secondly, he states that the lateral circuit should be a good conserver of energy, which statement he qualifies by the expression "not unreasonably wasteful". This qualification expresses a condition which is, of course, highly desirable, but not specified in the patent—it also is not a condition which is necessary for the carrying out of the objects of the Marconi patent.

Thirdly, he states that the oscillations in the lateral circuit should persist as long as possible and shall feed their energy slowly into the antenna without stopping unnecessarily early.

It is at this point that Mr. Loftin's conception of the Marconi system becomes entirely incorrect. There is no single word in the patent which supports his statements and there is a great mass of information which is diametrically opposed to it. This information is contained in the constructions which Marconi so minutely details and which, as I have previously pointed out and explained, indicate a wide variety of couplings and, therefore, a wide variation in the rates at which energy is transferred to the antenna circuit. These constructions show, or rather some of them, that the energy was transferred slowly, and in some others, the energy was transferred relatively rapidly, and in all cases they disclose the work of a practical man who knew how to make the transmitter work and was not interested in any fine-spun theories. Mr. Loftin's point relative to slowly feeding the energy into the antenna through a coupling sufficiently loose so as not to disturb the frequency of the oscillations in the lateral circuit rests purely on his own misconception of the requirements of the patent and is, for the reasons pointed out in connection with his third point, quite unsupported by anything disclosed in the patent.

His fifth point is a direct misstatement of the wording of the patent. He says:

"and, fifth, to adjust the antenna or good radiating circuit to have a natural period the same as the frequency period of the oscillations in the lateral circuit—that is, to get the resonant transfer of energy described by Lodge."

Reference to the patent shows that Marconi has nowhere instructed the adjustment of the antenna circuit in any way whatsoever relative to the frequency of the oscillations

[fol. 1234] in the closed circuit; what he does state, however, is found for instance, page 2, line 118 to line 129:

"The capacity and self-induction of the four circuits—*i. e.*, the primary and secondary circuits of the transmitting-station and the primary and secondary circuits at any one of the receiving-stations in a communicating system—are each and all to be so independently adjusted as to make the product of the self-induction multiplied by the capacity the same in each case or multiples of each day—that is to say, the electrical time periods of the four circuits are to be the same or octaves of each other."

This is a complete clean cut instruction to any electrical man as to how to relate the electrical constants of the circuits. Marconi has found out that when he does this he gets the best results, and, like the good practical man that he is, he sets down the facts and leaves the theorizing to others. Not only are his instructions in this respect perfectly clear and concise, but they are also of such a fundamental nature that no alternative has ever been found.

In answer to Q. 22, on page 1052 of the Printed Record, Mr. Loftin comments on Mr. Waterman's answer, commencing at page 145 of his deposition relative to the persistency of the oscillations in the closed circuit. He quotes Mr. Waterman as follows:

"Hence the amount of energy, and consequently the distance that could be reached with a given wave length by the original Marconi arrangement having the spark gap in the antenna, was limited by the small capacity of the antenna and the low charging pressure that could be applied to it on account of the presence of the spark gap."

Mr. Loftin argues from this quotation that a very slow transfer of energy is required, a statement which is entirely contrary to the facts, since, as is well known, two or three oscillations in the primary circuit, lasting an exceedingly short time, are quite sufficient to transfer relatively large quantities of energy to the antenna system without the production of excessive potentials.

Mr. Loftin next refers to the quotation:

"the approximately closed circuit of the primary being a good conserver."

and states that:

"This requirement has no meaning unless the energy remains long enough in the primary or lateral circuit for conservation."

In these quoted statements of Mr. Loftin, he appears to be arguing facts relative to the operation of a radio transmitter from an expression which is merely descriptive of a type of circuit.

While Mr. Marconi has used the expression "good conserver" to describe the characteristics of the closed oscillating circuit, he does not anywhere state that this circuit, when in operation, and coupled to another circuit, shall hold the energy as long as possible. He does not so state for the very simple reason that he does not want it to do anything of the kind but, on the contrary, wishes to get it [fol. 1235] into the antenna circuit where it will be useful. In some of the structures which he has described he allows the energy to remain in the closed circuit a relatively long time; that is, when he uses five per cent coupling; while in other cases the energy remains a relatively short time as, for instance, when he uses a nineteen and one-half per cent coupling.

The fact that the closed circuit is a good conserver of energy, therefore, does not mean that it is being used in a radio transmitter for the purpose of holding the energy as long as possible, but that it is used for the purpose of holding the energy as long as may be necessary for the purpose of transferring it to the antenna circuit. How rapidly it may be transferred depends upon conditions as, for instance, the resistance of the antenna circuit, or the cooling of the spark-gap. Since the energy in the closed circuit is of no use while it is there, it is perfectly obvious that it is desirable to get it into the antenna circuit as quickly as possible. This is a fact which has been recognized by every practical worker in the radio art but, while highly desirable, though the quick transfer of energy is, it was not possible at first to realize all of the possibilities in this direction. Mr. Loftin has pointed out, and I have briefly discussed, the complex and undesirable wave-train illustrated in "Claimant's Exhibit No. 219" resulting from too close an association between the open and closed circuits. This results from the fact that the

spark-gap used did not cool sufficiently, so that, after the energy had been transferred to the antenna circuit, the spark-gap did not go out, and so the energy was re-transferred back to the primary circuit. This action was recognized very early in the radio art and continued efforts were directed toward the improvement in the spark-gap for the purpose of making it cool more quickly, and as time went on, closer and closer couplings, that is to say, more and more rapid transfer of energy from the closed to the open circuit, became possible.

Mr. Loftin refers to the third requirement of the quotation to the effect that the local circuit shall be a "persistent oscillator" and he reiterates again that this means long-sustained oscillation, but since this argument is, I believe, completely met by my statement above, it appears unnecessary to indulge in further comment.

Mr. Loftin's fourth statement, in which he says:

"electrical oscillations are set up in the circuit which persist or are maintained for a long time—in the primary circuit."

again uses language which is descriptive of a type of circuit and not of facts of operation to infer and argue conclusions relative to operation which are totally contrary to the intent of the Marconi patent 763,772, the disclosures thereof, and many years of practical experience in the use of Marconi's arrangement.

* * * In my opinion, the language which describes the particular sort of circuit used by Marconi for his closed circuit implies nothing whatsoever relative to the functioning of that circuit when used in combination with the radiating circuit and I know as a matter of practical experience of a very extensive sort, that the Marconi arrangement does not require that the electrical oscillations which are set up in the closed circuit shall persist for a long time, when the transmitter is in actual operation. [fol. 1236] Q. 195. At the bottom of page 1045 of the Printed Record, and on page 1046, Mr. Loftin refers to certain pages of Zenneek's book ("Defendant's Exhibit H 6"); will you please consider the pages referred to by Mr. Loftin and state in what way the matter referred to by him and other matter contained in said book are pertinent on the question of coupling?

A. Mr. Loftin has used the quotation from Zenneck to illustrate what happens when the two circuits of an oscillator are coupled together in a manner which he calls "extremely loose", this extreme looseness being indicated by the fact that there is no appreciable reaction between the closed and open circuits. This is the sort of coupling which Mr. Loftin, as I understand his deposition, believes to be the sort of coupling which the Marconi patent infers.

As I have already pointed out several times in my answers, I consider this inference as entirely without support from the disclosures of Marconi patent 763,772, and quite contrary to the practice of the art.

There is a difference between a loose coupling and an "extremely loose" coupling, which is of great practical importance. When the coupling is so loose that there is no appreciable reaction between two associated circuits and if we neglect entirely the cutting-off action of the spark-gap, then the theoretical requirements for a single frequency in the secondary circuit exist. This, however, is an ideal of theory which is impossible of realization and which, if realized, would be quite useless for the simple reason that if the coupling between circuits is so loose that there is no reaction, there will then be no transfer of energy and, consequently, no usefulness in the combination. In order to transfer energy we must, of necessity, close the coupling up to some point which will be satisfactory from the practical requirements of operation. These practical requirements are, first, the transference of energy; secondly, a reasonably pure wave in the secondary circuit and these two things are of such a nature that they call for exactly the opposite condition in the matter of coupling: that is to say, the closer the coupling up to a certain point, the more energy we can transfer. On the other hand, the looser the coupling the purer the wave in the secondary circuit. From which it obviously follows that the practical adjustment must be a compromise and a coupling chosen which transfers the energy reasonably and gives a reasonably pure wave form, the criterion of reasonableness being, of course, the knowledge derived from practical experience.

Due to the action of the spark-gap in cooling rapidly, and thereby restoring its initial high resistance, the degree of coupling which may be employed without seriously distorting the wave form is much closer than that indicated by

the theoretical treatment of Bjercknes, referred to on page 85 of "Wireless Telegraphy" by Zenneck and translated by Seelig, dated 1915, and which forms the basis for the explanation which Dr. Zenneck sets forth.

This theoretical treatment, while it takes account of the resistance in the coupled circuit, takes no account whatever of the cutting-off action of the spark-gap, which action exists in all practical forms of radio transmitters employing a spark-gap and tuned coupled circuits and is the controlling factor in determining the degree of coupling permissible without distortion of the wave form. While this [fol. 1237] theoretical treatment of coupled circuits is important and useful to students of the fundamental actions in electrical circuits, it is of very little significance or help in understanding the action of circuits containing a spark-gap and for this reason I am unable to find any support in this publication for Mr. Loftin's position in the matter of the operation of the wireless telegraph system described in Marconi patent No. 763,772.

Paragraph c, page 85 of the book referred to, contains a statement distinguishing a loose coupling, involving an appreciable reaction, from the extremely loose coupling, in which no appreciable reaction exists, and the paragraph also explains that the result of this association is to increase the apparent resistance of the driving circuit. This is equivalent to putting a load on the driving circuit and relates to a condition more nearly approximating that of practical operation than the extremely loose coupling outlined in paragraph 56, page 85, referred to by Mr. Loftin.

It does not, however, bring out the dominant fact controlling the degree of coupling, viz., the cutting-off action of the spark-gap.

Q. 196. Referring to Mr. Loftin's consideration of the claims of the Marconi patent in suit, No. 763,772, beginning at the middle of page 1046 of the Printed Record, will you please state wherein you may differ with him in his conclusions as to the meaning of the technical terms of said claims?

A. Mr. Loftin, in his treatment of claim 1 of Marconi patent 763,772, at the bottom of page 1046, argues that the statement in the claims which reads:

"discharging through a means which automatically causes oscillations of the desired frequency."

requires that the open circuit and the closed circuit shall be loosely coupled, for he states, at the top of page 1047 of the Printed Record:

"It is therefore clear that the 'means' referred to in claim 1 requires that the lateral circuit and the elevated conductor or open circuit shall be loosely coupled."

This is a most astonishing conclusion, with no basis whatever, which I am able to find, except Mr. Loftin's consistent attempt throughout his deposition to read "loose coupling" into the Marconi patent 763,772. If we examine the language of claim 1, we find, lines 30, 31 and 32, the statement: "a condenser discharging through a means which automatically causes oscillations of the desired frequency;"

From the diagram of the closed circuit in Fig. 1 and from well known electrical principles, it is evident that the condenser *c* can only discharge through the circuit *c*, *d*, *C*. This discharge cannot take place in any way through the associated antenna circuit; consequently there can be no basis for including this antenna circuit in explaining the meaning of the expression contained in the claim.

The significance of the expression is still more closely defined by consideration of claim 6, lines 29 to 32, which state:

"and whose primary is connected to a condenser-circuit [fol. 1238] discharging through a means which automatically causes oscillations of the desired frequency."

The only possible condenser circuit for the discharge to take place is shown in Fig. 1, and consists of the condenser itself *c*, the inductance *d* and the spark-gap *C*, together with the necessary connecting wires, and the only element of this combination which has an automatic action of any kind in the production of electrical oscillations, is the spark-gap *C*. This automatic action is as follows:

The induction coil shown in the diagram charges the condenser *c* until the spark-gap breaks down, becomes conducting and permits of the oscillatory discharge of the condenser. After the oscillations have ceased, this spark-gap must automatically, that is, by its own action, recover its high resistance again since, if it does not, the voltage produced by the induction coil will flow through the spark-

gap and will be prevented from charging the condenser. It follows, therefore, that this spark-gap is the thing referred to by the expression in claim 1 under the designation of "means which automatically causes oscillations of the desired frequency".

There is no justification, therefore, in my opinion, for extending the meaning of this expression to cover the coupling between the circuits, either in the light of any understanding of this term by those skilled in the art, or in the disclosures of the patent itself.

On page 1049 of the Printed Record, Mr. Loftin has summarized the transmitting claims, and he states:

"Summarizing the group of transmitting claims above listed, it is to be noted that in no one of the claims does Marconi claim the two circuits actually in resonance."

Resonance being an electrical phenomenon, is outside of the possibilities of any patent claim, as I understand patent law and, therefore, seems to require no further comment.

Mr. Loftin states further:

"The claims include 'means' for adjusting the time periods of the circuit, in some cases naming the specific devices; that is, Marconi only included in his claim the instrumentality for accomplishing the result".

Marconi patent No. 763,772 is an "apparatus" patent, and not a "method" patent, for which reason, very naturally, the claims are confined to apparatus.

Mr. Loftin next states:

"Adjusting the time period of circuits was old at the time of the Marconi application, and these claims clearly show that Marconi fully appreciated this and made no claim to two circuits having time periods in accord with each other. He merely included in his claims an enumeration of instrumentalities adapted to conveniently adjust the circuits to secure this relation."

This statement gives a totally incorrect impression of the claims of the patent, since they are directed to means which resulted in a great epoch-making advance in the art of Wireless Telegraphy, while Mr. Loftin states that it was old to adjust the time-period of electrical circuits, [fol. 1239] he does not state that it was old to adjust time-

periods of the two circuits at a transmitting station and two circuits at a receiving station in resonance with each other, which is the all-important disclosure of this patent.

The statement that Mr. Marconi "made no claim to two circuits having time periods in accord with each other" creates a quite erroneous impression, since while the language of the claims is necessarily restricted to means for bringing the circuits into accord with each other, the result of the employment of these means is that the two circuits are brought into tune and the great improvement in the art of radio telegraphy is secured.

On page 1051 of the Printed Record, Mr. Loftin states:

"Summarizing this group of receiver claims, I do not find any requirement by Marconi that the two circuits at the receiving station shall be adjusted to accord in time periods or adjusted to resonance. This clearly shows that Marconi fully appreciated that the art prior to him had disclosed this feature and Marconi made no claim thereto. His claims are for the means or instrumentalities for adjustment in combination with other specific elements."

As in the transmitter claims, the receiver claims are, of necessity, since this is an apparatus patent, drawn to means necessary for accomplishing the objects of the patent. When the means so claimed are employed as directed in the specification of the patent, the two circuits at the receiving station are adjusted to resonance, or to accord in the time-periods; this result which is secured by the apparatus of Marconi patent 763,772, is in direct contradiction to Mr. Loftin's statement quoted above, to the effect that there is no requirement by Marconi that these circuits at the receiving station should be in tune. As a matter of fact, the employment of the means claimed in these claims not only produces this result, but the specification recognizes it and requires it in quite unmistakable language on page 2, lines 118 to 129, where it states:

"The capacity and self-induction of the four circuits—*i. e.*, the primary and secondary circuits at the transmitting station and the primary and secondary circuits at any one of the receiving stations in a communicating system—are each and all to be so independently adjusted as to make the product of the self-induction multiplied by the capacity the same in each case or multiples of each

other—that is to say, the electrical time periods of the four circuits are to be the same or octaves of each other.”

On page 1052 of the Printed Record, Mr. Loftin summarizes his opinion of the three groups of claims in language similar to that already quoted in so far as the receiver claims and transmitter claims, taken separately, are concerned.

In so far as those claims involve four circuits, Mr. Loftin states that he has claimed resonance for the four circuits, in spite of the showing in the prior art of radio systems having two tuned circuits at the transmitter and two tuned circuits at the receiver. With respect to this statement, I will merely make the comment that I have been quite unable to find anywhere in the prior art any [fol. 1240] showing of two coupled tuned circuits at the transmitter, or of two coupled tuned circuits at the receiver, or of any complete radio system involving a combination of the transmitter and receiver above specified.

As I have stated in the preliminary part of my deposition, I have taken part in most of the litigation involving Marconi patent No. 763,772 which has taken place in the United States, and am generally familiar with the prior art relied upon by the defense in these various cases and interpreted by various Experts, and my opinion, above stated, is based on this experience and the knowledge obtained therefrom.

Q. 197. Will you please describe briefly the various kinds of spark-gaps capable of use with the tuned transmitting circuits of the Marconi patent in suit, No. 763,772, giving a brief outline of their development, and state in what respects their operation and effect in said circuits are similar? In answering this question please refer to X Q. 106 and the answer thereto of Mr. Loftin's deposition (page 1164 of the Printed Record), and state to what extent you agree with his answer to that question.

A. A great variety of spark-gaps has been used in radio and much labor and ingenuity been expended in efforts to prove the effectiveness of this device. It was recognized by the workers in this art almost, if not quite, from the very start of radio that cooling was an essential feature and that the more effective the cooling, the more effective was the operation of the gap. The reason for this effectiveness is simple and has already been pointed out in

some of my previous answers, and is the fact that the cooler the gap is, the greater is its power of automatically restoring its initial condition of high resistance. When a circuit containing a spark-gap, such as that shown in the Marconi patent No. 763,772, Fig. 1, is coupled to an antenna circuit, the effect of the coupling and the extraction of energy by the antenna circuit is to decrease the number of oscillations which would otherwise take place in the closed circuit, and the closer the coupling the more rapid is this decrease.

When, due to this action, the oscillations in the primary or spark-gap circuit have been reduced down to a very small value, if the gap is effectively cooled it will automatically restore itself to its original condition of high resistance, and the oscillations which are taking place in the antenna circuit will not be transferred back again into the spark-gap circuit, thereby causing a complex and undesirable wave form and useless waste of energy.

All of the types of spark-gaps used in practice have this capability to a greater or less extent. At first, as is shown [fol. 1241] in the Marconi patent No. 763,772, a type of gap was sometimes employed which consisted of two metallic spheres on the ends of metal rods. This type of gap had some cooling capabilities, particularly when used with small powers.

Reference has already been made in a previous answer to the type of gap illustrated in the Marconi Re-issue patent No. 11,913 and in the British Tesla patent No. 20,981, of 1896 ("Defendant's Exhibit Y-2"), which have greater cooling powers than the single pair of spheres.

In the "Manual of Wireless Telegraphy for the Use of Naval Electricians", 1911 Edition, by Commander S. S. Robison, U. S. Navy, there is shown on page 105, "Plaintiff's Exhibit 100", a number of spark-gaps of different construction which represent the development of this device and the methods adopted to secure satisfactory cooling.

Fig. 54 shows a simple form, consisting of two metal rods with rounded ends, on which is directed an air blast. Fig. 55 shows a spark-gap consisting of two metallic strips having a considerable surface for radiating heat. Fig. 60 shows a spark-gap in which the electrodes are hollow and compressed air, for the purpose of cooling, forced through them. Fig. 61 shows two metallic rods with rounded ends

and a metallic plate of large surface interposed between them and dividing the spark-gap into two sections. Fig. 58 shows a number of sets of spherical ball spark-gaps, in series with each other, which result in the sparks being broken up into a number of small parts.

All of the spark-gaps above described belong to the class known as "fixed gaps" and are good illustrations of the expedients adopted to increase the cooling of these devices.

The next step in the development of the spark-gap is illustrated in Fig. 53 as a non-synchronous rotating spark-gap. "Claimant's Exhibit No. 212" shows a form of this gap adopted by the United States Navy and referred to by Mr. George H. Clark, on page 1496 of his testimony. In this device one set of electrodes is fixed, while the other terminal consists of a number of studs attached to a rapidly-rotating disk. This type of gap operates in two ways to put out or quench the spark, viz., a marked cooling effect, due to the rapid rotation, and the fact that on the rotating element each stud handles only a portion of the total number of sparks. In addition to this, the rapid rotation of the gap draws the rotating electrodes away from the fixed electrodes, thereby mechanically increasing the length of the spark-gap and its resistance, and therefore its tendency to go out.

The word "non-synchronous" used in connection with this type of spark-gap signifies that the rate of rotation of the spark-gap is not definitely related to the rate of rotation of the generator which supplies the alternating current power.

In "Plaintiff's Exhibit 112", there is shown a spark-gap of this type connected in the circuit of a Navy transmitter, and Mr. Clark, on page 231, testifies to the effect that practically every quenched spark-gap set purchased by the Navy had as an auxiliary a spark-gap of this type. This statement of Mr. Clark's is relative to the time down to the date of his leaving the Navy in 1919. It happens also that I know from my own personal experience that large numbers of spark-gaps of this type were employed [fol. 1242] by the Navy Department as auxiliaries to quenched sparks and used in the identical circuits in which the quenched spark-gap was used.

Many of these sets were manufactured by the Marconi Wireless Telegraph Company under my supervision, and I saw others in the Navy Yard, manufactured by various

competing companies. I saw most of these spark-gaps during the period when the United States was in the World War.

In Fig. 52 of the "Manual of Wireless Telegraphy" is shown a synchronous rotating spark-gap, whose general action is similar to that of the non-synchronous spark-gap, except that it is usually attached to the shaft of the generator and I find on page 425 of the "Proceedings of the Institute of Radio Engineers" dated October, 1916, an illustration of a gap of this type used by the Government at its Arlington station. This particular spark-gap was one of the largest of its kind that was ever constructed and I happen to have been one of those who did the work of designing and testing this device while I was with the National Electric Signaling Company. ("Plaintiff's Exhibit No. 81," pages 424 and 425.)

As will be seen from the statement under this illustration, this spark-gap handled a very large power, viz., 100 kilo-watts and gave very satisfactory practical operation.

The rotary spark-gap represents the second stage in the development of effective cooling means for spark discharges, while in Fig. 57, page 105, of "Plaintiff's Exhibit No. 100," there is shown the third and last practical development of spark-gaps with effective cooling, which is called the "quenched" spark-gap. This spark-gap consists of a number of circular plates, separated by insulating materials and the separation between the sparking surfaces is very small. The number of such plates are usually varied from five or six up to fourteen or fifteen. The surfaces between which the sparks actually took place were highly polished, circular in form and about two and a half inches in diameter, and were attached to cooling flanges in order to quickly radiate away the heat.

Due to the large number of very small gaps in series, the large sparking surface and the large cooling flanges, this type of gap has greater capabilities in the matter of extinguishing the spark than any of the types previously mentioned. This property of rapidly cooling and extinguishing the spark is one common to all of the types of spark gap above described, and the differences between the various types are merely differences in degree, since the action in all of them is identical.

With this action of the spark-gap in mind, it will, perhaps, be of interest to note that in the actual operation

of a radio transmitter this action has been a controlling one in the matter of the degree of coupling which could be employed. In all cases it has been the universal practice to adjust the coupling between the closed circuit and the open circuit as close as was possible, without the production of a complex wave form.

With the first type of simple fixed spark-gap a particular order of coupling would be found in practice which would meet this condition, but when a spark-gap of the rotary type was substituted, it would be found that a [col. 1243] closer coupling was possible, without spoiling the wave form and a greater efficiency in the transfer of the oscillations to the open circuit realized.

When the quenched spark-gap was developed, it was found that a still closer degree of coupling could be employed and a still greater efficiency could be secured. In all cases the coupling employed was of such a nature that, with the particular spark gap used the oscillations in the primary circuit stopped, due to the quenching action of the gap at the time when their amplitude was reduced nearly to zero. The more perfect the quenching action, the closer the coupling which could be employed (without the energy from the secondary circuit transferring back to the primary circuit), and the smaller the number of oscillations taking place in the primary circuit during the transfer.

In addition to the similarity in the matter of quenching between all types of gaps to which I have just referred, is the fact that all of them are most effectively employed in the tuned coupled circuits of Marconi patent No. 763,772; regardless of which type of gap is used, the spark-gap circuit must be tuned to the open antenna circuit in order to transfer the energy effectively and I have personally on numerous occasions, made the experiment of using all three types of gap one after the other in the same circuit arrangement, and found that the tuning adjustments for all three were the same, but that the coupling adjustments was loosest with the plain gap, closer with the rotary gap and greater still with the quenched gap.

I note that Mr. Loftin, on page 1164 of the Printed Record, in answer to X Q. 106, states that the Marconi patent 763,772 is not limited to any particular kind of gap and

with this statement I agree. His further statement, however,

"I have contended that the Marconi patent, and its transmitter claims, is limited to a system in which oscillations of but one and the desired frequency are created in the primary circuit of a transmitter and are transferred at this one and desired frequency into the secondary circuit, or radiating circuit, without change in frequency."

is not at all in accordance with the disclosures of the Marconi patent and I am in complete disagreement with it.

The patent says nothing whatever about the mechanism of the transfer of energy from one circuit to the other, other than to specify the apparatus necessary for the purpose and the further fact that the circuits shall be in tune, and these requirements of the patent constitute the complete and necessary disclosures for the purpose of making a wireless telegraph transmitter with coupled tuned circuits.

Mr. Loftin's concluding statement in this answer is:

"I have contended, however, that for the 'best results' in the matter of getting a persistent long drawn out train of oscillations in the primary circuit the open-gap form is the preferred form."

This contention appears to me to be directed toward something which is neither of interest nor consequence in the operation of a wireless telegraph transmitter, and which is not one of the objects set forth in the Marconi patent. On the contrary, it appears to me, for reasons [fol. 1244] previously set forth at some length, to be a totally undesirable result and one which the art has made every effort to get away from.

Here again, it seems to me that Mr. Loftin is extending the language used by Mr. Marconi to describe a type of circuit to the point of describing an action after that circuit is coupled to an open radiating circuit, and this extension, in my opinion, is without justification, either in the facts of operation, or the patent itself.

Q. 198. Please refer to Mr. Loftin's answer to Q. 24 on page 1058 of the Printed Record, in which he discusses the effect of different degrees of coupling and criticizes Mr.

Waterman's Sketch No. 2, and state wherein you agree or disagree with Mr. Loftin's statement.

A. I have read Mr. Loftin's reply to Q. 24, page 1058, and I do not agree with his remarks relative to Mr. Waterman's statements on page 151 of the record, wherein he explains certain facts relating to the transfer of energy from a primary circuit to a secondary circuit.

As I understand Mr. Waterman's explanation, he has illustrated in *a* of Waterman Sketch No. 2, oscillations taking place in the closed reservoir circuit of the Marconi transmitter and brings out the fact, to which I have just referred in my last answer, that when the oscillations of the primary circuit reach a certain minimum value they will if the coupling adjustment is right, cease entirely, due to the opening of the spark-gap, while the secondary circuit will go on oscillating without disturbance from the primary circuit until it dies out.

Mr. Loftin interprets Mr. Waterman's statement, which he quotes in the middle of Printed Record, page 1059, and which is:

"It is important, therefore, in order that the efficient radiation to which the patent refers may be secured that the association between the two circuits should not be so close as to permit the secondary circuit to break down the spark gap by reaction upon it."

to be a direction to employ a loose coupling in accordance with Marconi patent 763,772.

Such an understanding is, to my mind, quite unjustified by Mr. Waterman's statement but, on the contrary, I find that it is an entirely correct technical statement of the adjustment requirements of a Marconi transmitter, viz., that the coupling should not be too close for the type of spark-gap employed.

Mr. Loftin further contends; as he has consistently throughout his deposition, that the Marconi patent specifies "loose coupling", and that for this reason Mr. Waterman, in his Sketch No. 2, has illustrated a type of action of which the Marconi transmitter is incapable.

This statement is, of course, totally contrary to the facts, since, as I have previously pointed out, the degree of rapidity with which energy can be transferred from one circuit to another in the Marconi tuned coupled transmitter is merely a matter of the type of gap employed.

Mr. Loftin states:

"As a matter of fact, the cessation of oscillations in the primary circuit is not determined by the association of the two circuits, but upon spark gap conditions opposed to [fol. 1245] those which are necessary to secure the long drawn out persistent oscillations in the primary circuit of the Marconi invention."

This statement is entirely misleading, both in so far as it infers the necessity for persistent oscillations in the primary circuit of the Marconi invention, and in its reference to spark-gap conditions, which are in opposition to the requirements of the Marconi patent.

As I have pointed out many times in my deposition thus far, the Marconi patent does not specify, and does not require, long drawn out oscillations in the primary circuit, when that circuit is coupled to an antenna and in my last answer I have shown that the action of spark-gaps of all types is similar and that they differ only in the degree of cooling and, therefore, spark-extinguishing capabilities.

Mr. Loftin's criticism to the effect that no open or plain gap will function to cut off energy in the manner shown in *a* of Waterman Sketch No. 2 is quite without justification, since Mr. Waterman in his explanation of this figure, has made no reference to any particular type of spark gap.

Mr. Loftin further states that there is no foundation of Fig. 2 in the Marconi specification and then proceeds to state that the figure is a counterpart of that shown in most text-books as typical of the action of the quenched gap type of radio transmitter, which type of transmitter is, as a matter of fact, the arrangement of the Marconi patent No. 763,772.

Referring to this type of transmitter, Mr. Loftin states that it was an invention made some ten years subsequent to the Marconi invention, which statement I consider entirely incorrect since, from my own experience I know that the invention referred to could only be the particular type of gap.

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Q. 199. Will you please illustrate by a diagram or curves, the relative forms of wave trains in the primary and secondary circuits of an open-gap loosely coupled transmitter, as compared with the forms of wave trains in the

quenched spark closely coupled transmitter, and explain how they are arrived at; also please state in your explanation whether or not the circuits of the quenched gap transmitter are in resonance, giving your reasons for your conclusions.

A. On page 94 of Seelig's translation of the work entitled "Wireless Telegraphy" by Zeenneck ("Defendant's Exhibit H-6") are found two sets of curves, one illustrative of the action taking place in a quenched spark-gap transmitter with close coupling, and the other showing what takes place with an open gap, and the same close [fol. 1246] coupling and these curves illustrate, in a simple way, the cutting-off action of a spark-gap having a high degree of cooling; such, for instance, as the quenched spark-gap and the sort of wave train which results from a close coupling when the cutting-off capabilities of the spark-gap are insufficient.

The two upper curves of Fig. 130 show that the oscillation in the primary circuit starts at a high value and is very rapidly, after about three oscillations, reduced down to zero, while the secondary oscillation rapidly builds up during this time.

Reference to the lower curves, Fig. 131, illustrative of the quenched spark-gap, shows that during this same period the action taking place in the circuit containing the quenched spark gap is identical, and this is the period during which energy is transferred from the primary circuit to the secondary circuit, due to the coupling between them and the fact that they are in tune.

Referring now to the upper two curves, it will be noted that when the primary current is at zero, the secondary current is at maximum, and that, for the next few oscillations the secondary current decreases, while the primary current rapidly builds up to maximum. This action continues and is repeated several times, resulting in a sort of waxing and waning of the wave train.

This is the complex wave form to which I have several times referred in my previous statements and it is mathematically analyzable into two principal frequencies, often referred to as the "coupling frequencies".

It will be noted in the lower two diagrams that when the primary oscillation falls to zero it ceases altogether, due to the fact that the great quenching power of the quenched gap has caused it to open. It will also be noted that the

secondary oscillation decreases slowly for a long period of time, and this is illustrative of the fact that, due to the opening of the gap, no energy from the secondary circuit is fed back into the primary circuit, with the resultant distortion of the wave form.

The state of affairs which is represented in the two upper curves is, from the standpoint of practical operation and use of the open gap, undesirable and is the result of an improper adjustment of the coupling; that is to say, a coupling which is too close for the quenching capabilities of the open gap.

In the sketch which I produce (Claimant's Ex. 243), I have shown the oscillations in a circuit with an open gap, in which the coupling is correctly adjusted, and it will be noted that the wave forms of both the primary and secondary circuits are similar to those of the quenched spark-gap shown on page 94 of the Zenneck book.

In the sketch which I have produced, there are more oscillations in the primary circuit than are shown in Fig. 130 for the quenched gap which I have just described, because the coupling is, of necessity, looser and the energy, therefore, is transferred to the secondary circuit more slowly. It will be noted also, however, that when this oscillation reached the zero point it ceases, exactly as in the case of the quenched spark-gap.

It will be seen also that the secondary oscillation builds up in the same manner as the secondary oscillation of the [fol. 1247] quenched spark-gap, but more slowly, due to the looseness of the coupling, but that it dies out in the same slow fashion as does the oscillation of the quenched spark-gap arrangement.

The curves which I have produced are illustrated of the action of tuned coupled circuits containing an open gap when the coupling between these circuits is correctly adjusted; that means, is as close as it can be, without the energy from the secondary circuit being transferred back into the primary circuit, due to the failure of the spark-gap to go out.

It will be seen from this description that the action of Marconi tuned coupled circuits containing either an open spark-gap or a quenched spark-gap is identical in principle; that in both cases the proper adjustment of the coupling is that adjustment which transfers the maximum energy, without distortion of the wave form; that is to say, in

both cases the coupling should not be so tight that the spark-gap is unable to open after the primary oscillation has been reduced to some small value, and that the oscillation in the secondary circuit is that due to the antenna oscillating in its own natural way, without interference from the primary circuit.

In the transfer of energy from the circuit containing the spark-gap, that is, the closed reservoir circuit, to the antenna circuit or open radiating circuit, there is a relation between the electrical constants of these circuits which is vital. This is, that the condition of resonance shall exist, that the circuits shall be in tune, or, as stated in the Marconi patent 763,772 specifically the product of inductance and capacity in one circuit shall equal the product of inductance and capacity in the other circuit. This is a fundamental law, and tuned coupled circuits obey it, regardless of the type of the spark-gap employed. While it is true that some technical writers, in treating of the action of such circuits with a quenched spark-gap in them, have occasionally referred to a slight mis-tuning between the circuits, I know that these references are the result of insufficient experiment or improper handling of the apparatus.

It so happens that in the course of my long experience in radio I have supervised the design, construction and operation of thousands of tuned coupled circuit transmitters employing the quenched spark-gap, and I have tested, in the most thorough and complete manner possible, many times, and with many different transmitters, the question of resonance between the closed and open circuits and from this experience I am able to make the positive statement that quenched spark transmitters must be tuned in exactly the same way, and for exactly the same reasons, as the same circuits used with the open type of spark-gap.

While there are occasional brief references in the literature of the art to slight mis-tuning between the circuits of the quenched spark-gap transmitter, there are numerous other references which indicate clearly a recognition by the authors of the existence of the fact that these circuits are tuned.

On page 408 and 409 * * * (Claimant's Ex. 244) of the work entitled "Robison's Manual of Radio Telegraphy and Telephony for Use of Naval Radiomen" by Commander (now Admiral) S. S. Robin, U. S. Navy, published by the

[fol. 1248] United States Naval Institute 1924, there is a description of the action of coupled circuits containing the quenched spark-gap.

At the bottom of page 408 is a paragraph referring to Figs. 272 and 273, which figures are curves similar in nature to those of Fig. 131 of the Zenneck book, which I have just described.

This paragraph states:

"Such would be the ideal way, but the actual equipment used permits a series of surges through the gap as indicated in figure 272. The resulting induced antenna current is shown in Figure 273. If the time periods or frequencies of the two circuits are not the same under these conditions, a very small energy transfer takes place. It, therefore, becomes of first importance that the primary oscillatory and the antenna circuits be adjusted to identical time periods. For this it is necessary that the $L_1 C_1$ value of one circuit equal the $L_2 C_2$ value of the other. This does not mean that L_1 must equal L_2 and C_1 equal C_2 , but it does mean that the product of L_1 and C_1 expressed in henries and farads, or convenient subdivisions, must equal the product of L_2 and C_2 expressed in the same units."

This quotation shows very clearly that the authors of the Navy Manual in issuing instructions on the subject of Radio to Naval electricians, recognized and taught that the circuits of the quenched spark-gap transmitter were tuned.

I find also, on page 1096 of the Printed Record, that Mr. Loftin, in referring to the Wireless Specialty Apparatus Company transmitters, and others of similar type, has stated that these were the kind of wireless transmitters described in patent No. 1,216,615 to G. Seibt, and as I understand his statement at the bottom of this page, this Seibt patent discloses fully and completely that sort of transmitter which is today known in the art as the "quenched spark-gap transmitter."

It seems fair to assume that the inventor of this system would disclose his ideas and the results of his experience in the use of his system, and in this disclosure indicate whether or not the circuits are to be tuned.

I find in the File Wrapper of this Seibt patent a number of statements which very clearly show that Seibt considered

that the tuning of the associated circuits; that is, the closed circuit containing the quenched spark-gap and the antenna circuit, was of vital importance.

In Paper No. 8, Amendment B, and Affidavits received October 4, 1911, pages 4 and 5, is the following statement:

“ * * * The invention does not consist of a spark-gap; nor does it consist of a short spark-gap. It does, however, consist, among other things, as set forth in the claims, of a *combination* comprising, for instance, two inter-related oscillating systems, including a primary oscillating system and a secondary oscillating system, these two systems being in resonance with each other and being coupled together in such manner that by reason of the particular kind of spark-gap employed and of the other elements employed and fully described in the specification, the spark snaps off and the primary circuit is opened at the end of the first beat in the primary circuit and the coupled waves [fol. 1249] practically disappear, with the new result that powerful and useful slowly damped, free oscillations are produced in the secondary oscillating system, causing a beautifully clear, high, musical note, * * *

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It will be noted that this statement prescribes resonance between the two coupled circuits, that is, the closed reservoir circuit and the open radiating circuit, and that it describes the action in the matter of the cutting off of the spark in language similar to that which I have used in explaining the action of spark-gaps generally.

I next quote from Paper No. 15, Amendment C, received July 1st, 1912, page 4:

“ * * * In describing the commercial form of apparatus made in accordance with applicant's invention and shown in the photograph annexed to applicant's affidavit, the means and method of adjusting the coupling of the primary and secondary circuits ‘thereby enabling the operator to make the coupling of the two circuits sufficiently strong to secure the snapping off of the spark at the spark-gap at the end of the first beat’ are pointed out; and the affiants say that by listening at the receiving apparatus they could determine whether the note was clear or not and that if the note was not clear, they adjusted the coupling in the manner described and also brought the two circuits in

better tune with each other in the manner described, and furthermore, they regulated the potential of the current in the primary circuit of the transformer B, thus making the note clear."

This quotation describes a practical method of adjusting the apparatus and states that in order to make the note clear the circuits, that is, the closed reservoir circuit and the open antenna circuit were brought into better tune with each other.

I next quote from Paper No. 22, Amendment E, received July 18, 1913, page 20:

"* * * * * Wien did not disclose what applicant discloses—namely, means for producing powerful slowly damped free oscillations in the secondary circuit. In order to accomplish this result, which turned applicant's invention from a laboratory experiment into a practical, useful and commercial device, applicant brought the two oscillating circuits in tune with each other, coupled them in the manner described, employed a very short spark-gap having electrodes of high thermal conductivity and used a source of electrical current having a potential capable of quickly effecting a disruptive discharge across the spark-gap.

[fol. 1250] This statement expresses the inventor's belief that his invention lies in the use of the Wien spark-gap in a closed reservoir circuit tuned to the open radiating circuit, and his belief that, as the result of tuning these circuits he has converted the Wien device from a laboratory experiment into a commercially useful radio transmitter.

It would be difficult to find language more expressive of the importance of the tuning of the quenched spark-gap circuits than that quoted above.

I again quote from page 22 of Paper No. 22, Amendment E, received July 18, 1913, as follows:

"In further explanation of applicant's invention the following remarks may be made. Two circuits are in tune when an indicating instrument in the secondary circuit gives the maximum deflection. Applicant puts the two circuits in tune and then determines the best coupling, looking at the needle of an indicating instrument. The tuning depends on the capacity and self-induction and not on the coupling. In coupling applicant adjusts the circuits to get the maximum deflection of the needle of the indicating instrument. In applicant's combination of elements

described, when the coupling is correct, that is, when it is sufficiently strong the spark will snap off at the spark-gap at the end of the first beat of the oscillations in the primary circuit. Hence the importance of the proper coupling of applicant's elements, as stated in the specification and heretofore pointed out."

This statement constitutes the practical method of determining when the circuits of a quenched spark-gap transmitter are in tune and is the method which has been employed in practice for many years.

It also states that the coupling has nothing to do with tuning, which latter is governed solely by the capacity and self-induction. This statement is in strict accordance with the facts relative to the Marconi patent 763,772 which I have frequently brought out in my deposition. Marconi very carefully specifies the inductive and capacity of his tuned circuits, but says nothing in the matter of the coupling, leaving that to be determined by the circumstances of actual operation.

Mr. Loftin, in his answer to Q. 21, page 1017 of the Printed Record, describes the nature and operation of the Marconi patent and deals with the question of loose coupling and close coupling between the open circuits and the closed circuits.

In the course of this discussion Mr. Loftin deals with the complex wave form resulting from a too close coupling of two tuned coupled circuits and argues from his explanation that the Marconi patent discloses, or at least, infers loose coupling. He again, in his answer to Q. 29, page 1096 of the Printed Record, wherein he testifies relative to the action of the quenched spark-gap apparatus of "Plaintiff's Exhibit No. 87," takes up the question of resonance between the circuits and the manner in which energy is transferred from one circuit to the other.

In the course of his discussion he identifies the apparatus of "Plaintiff's Exhibit No. 87" with the Seibt patent No. 1,216,615, and attempts to interpret a statement in the patent, page 1, lines 62 to 70, which reads as follows:

"In the arrangement shown in Figure 1 two separate [fol. 1251] oscillations are produced, as is well known, even though the natural periods of the two circuits, I and II, are the same. In the case where these two circuits are in resonance with respect to their natural periods, the two

wave lengths of the system are given by the following formulæ, neglecting resistance—”

In the light of the quotations given in this answer from the Seibt patent, it is perfectly evident that there is only one possible interpretation of the inventor's use of the words resonance and tuning, and that is that he meant exactly what M. Marconi meant in his patent No. 763,772, viz., that the two circuits should have the same LC product, that they should be in tune.

In his answer to Q. 29, Mr. Loftin undertakes to explain that the purpose of the approximate tuning which he admits between the circuits of a quenched spark-gap transmitter is the production of beats, and that since an oscillation which takes the form of the waxing and waning, to which I have previously referred, sometimes called “beats” is analyzable into two principal frequencies, both of which are different from the periods to which the closed and open circuits are tuned, that this tuning plays no part in the transfer of energy.

This argument is totally contrary to, and unsupported by, the physical facts involved in the operation of a quenched spark-gap transmitter and is based on a totally incorrect picture of the mechanism by means of which energy is extracted from the closed circuit by the open circuit and an incorrect inference in the matter of the significance of the word “frequency.” He has used this word in such a way as to indicate that, in order for the energy to be transferred from the closed circuit to the open circuit the frequency of the oscillations in the two circuits must be the same and this statement is totally incorrect, for the following reasons:

The word “frequency” has two different meanings, one of which is the ordinary meaning, non-technical, and is represented by the motion of various things. As an illustration, suppose an ordinary clock pendulum is pulled a little to one side and allowed to swing back-and-forth until it stops. Each successive swing of this pendulum is of smaller amplitude, but the time taken to execute each swing is the same; as, for instance, one second; and, in the ordinary or lay significance of the word “frequency,” this pendulum then has a frequency of one cycle per second.

In the technical sense the word “frequency” is quite different and is confined to a motion which is known as a simple harmonic motion. It is customary to illustrate

graphically motions of both sorts by means of curves and the motion of the pendulum which I have described could be illustrated by the same curve as is used in Fig. 272, page 408, "Manual of Radio Telegraphy and Telephony by Robinson and Hooper," 1924 Edition, which illustrates the motion of electricity in a closed oscillating circuit and which shows that the swings are of constantly decreasing amplitude, but occupy the same time, this latter fact being indicated by the fact that the distance along the central horizontal line of the drawing is the same for each half cycle; that is, for each part of the curve above the line, and for each part below.

Referring now to "Weagant Sketch No. 2" (Claimant's Ex. 246), I have shown in the curve A a curve which is [fol. 1252] known as sine wave, which is a correct representation of a simple harmonic motion, that is to say, is the representation of that sort of motion which mathematically and technically is known as a "single frequency." The method of drawing this curve is illustrated in the little figure at the top of the sheet "Weagant Sketch No. 2." It will be noted that the successive amplitudes of this curve are equal; that the curve has a particular shape and that the time of each swing is the same. Now it so happens that this simple harmonic motion illustrated by the sine wave of my sketch No. 2 is a fundamental thing in nature and that when a motion of any other kind exists it is at once analyzable into several sine waves of the sort which I have described.

Regardless of the form of a curve which illustrates a motion, by combining the right number of sine curves having some particular frequency (usually many different frequencies), and the right amplitude, the particular curve under consideration can be secured.

For instance, the curve of Fig. 272, page 408 of the Navy Manual to which I have just referred, while representing a single frequency in the ordinary lay sense, represents very many frequencies in the technical sense. In general, it may be stated that if a curve is drawn representative of some sort of motion in which successive amplitudes are not equal, and in which the form is not that of the sine curve, that that wave form is a complex one and involves more than a single frequency, although the time between the successive zero points may be identical with the time between the successive zero points of a sine curve. Such,

for instance, is the curve shown in Fig. 274 or the curve shown in Fig. 275, which represent the motion of electricity in two circuits coupled too closely together for the particular spark-gap used.

In Weagant Sketch No. 2, in addition to curve A, I have drawn a second curve B, differing slightly in frequency, and I curve C, I have added the vertical ordinates of the two curves together, and it will be seen that I have obtained a resultant curve which is practically a duplicate of that shown in Fig. 274, page 409 of the Navy Manual. As will be noted, this curve represents the waxing and waning action which is sometimes referred to as "beats," and it is because of the fact that a complex curve of this sort can be analyzed into two or more components of simple harmonic form that a wave form of this kind is said to consist of two frequencies.

In the use of this particular instrument of mathematical analysis it is very important not to draw wrong conclusions therefrom relative to the physical phenomena involved and it is not possible, from this method of reasoning, to determine the nature of the physical phenomena which have given rise to the particular wave form. To illustrate this point, I may state that if curves A and B represent two high frequency alternating currents which are put into a detector of radio signals, they will combine to form a resultant electrical motion illustrated by curve C, and which, when rectified, will give a musical note of audible frequency, this frequency corresponding to the rate of occurrence of the zero points of curve C and this method constituting what is known as the heterodyne method of detection. When we examine the physical phenomena underlying the curves of Figs. 274 and 275, page 409 of the Navy Manual, we find a totally different thing.

Here we have oscillations existing in a closed primary [fol. 1253] circuit and which are the result of the electricity swinging back-and-forth in that circuit at a rate which is determined by its natural time-period. Due to the losses in the circuit, this motion would, if the circuit were alone, slowly die out, but due to the fact that the coupled circuit is rapidly extracting the energy from it, the motion dies out very rapidly, and quickly comes to zero. Since the energy now exists in the secondary circuit and since the spark-gap has not sufficient restorative powers, the secondary circuit now becomes the driving circuit and starts trans-

ferring the energy back to the primary circuit again. This results in a type of motion exactly like that of curve C of Weagant Sketch No. 2, but the physical phenomena involved are totally different.

The next point of vital consequence is the fact that the oscillations in the primary circuit of Fig. 274, while rapidly decreasing in amplitude, consume the same time, and are, therefore, in the ordinary sense of the word, of one frequency. Now it happens that in the transfer of energy from one circuit to another that the requirement is that the resultant motion of the electricity in these circuits should correspond with the natural time-period of the circuits, because in this transfer of energy an electrical circuit recognizes not "frequency" as defined by the mathematician, but "frequency" as understood in the ordinary lay sense. It is very easy to see this if we examine coincidentally the two curves Figs. 274 and 275 and note that the first half of the curve of Fig. 274 occupies the same length of time as the first half of Fig. 275.

Now Fig. 274 represents the driving circuit and during the time of this first half oscillation, the driving force is in one direction, represented by the distance above the curve. As the point where this curve crosses the zero line in Fig. 274, the curve of Fig. 275 also crosses the zero line, so that when the driving force reverses in the driving circuit, the electricity in the driven circuit is ready to, and does move, in the same direction, and this continues throughout the action.

If these circuits were not in tune, however, this action would not result, because the motion of the electricity in the driven circuit would not correspond to the driving force, since this motion is determined by the natural period of the circuit, and the result would be that when the first half oscillation of the driving circuit arrived at zero, the first half oscillation of the driven circuit would be either a little ahead, or a little behind, and after several half oscillations the motion in one circuit would oppose that in the other, with a resultant neutralization, and the transfer of very little energy.

In other words, electricity in a circuit will move back-and-forth at a rate which is determined by the natural time period of the circuit, and if driven by another circuit, in which the electrical motion has the same time-period, it will be helped in its motion by the associated circuit, but

if the time-periods of the two circuits are not the same, then the motion of electricity in one cannot support the motion of electricity in the other.

It is important in understanding this action, to have clearly in mind that this effective transfer of energy takes place when there is a coincidence in the time rates of the motion of the electricity in the two circuits and the natural period of the circuits, but that the shape of the wave form and, therefore, the presence of more than one frequency in the mathematical sense, is of no consequence.

[fol. 1254] When two circuits are coupled together and their time-periods are adjusted to be the same, then the motion of electricity in these two circuits is isochronous and the energy is most effectively transferred from one circuit to another.

.

On page 94 of Zenneck's book on "Wireless Telegraphy" translated by Seelig, 1915 Edition, there are shown two separate curves, Fig. 130, representative of the action of a close coupling between coupled circuits, having a gap of insufficient quenching powers and Fig. 131 representative of a quenched gap circuit, both circuits having the same degree of coupling.

It will be noted that during the time when the energy is being transferred from the closed circuit to the open circuit, that is, the time when the primary oscillation is decreasing from a maximum to zero, that the form of the curve is identical for both types of gap and this is a recognition by Zenneck of the fact that the action of transferring energy from one circuit to another has nothing whatever to do with the type of gap employed and the action here illustrated is strictly in accord with the explanations which I have just given.

Mr. Loftin, throughout his entire explanation of the action of the quenched gap, has referred to the adjustment of the quenched gap as being for the purpose of producing "beats" and one might infer from this statement that these so-called "beats" were the output of the radio transmitter. As a matter of fact, when the quenched gap is used and it opens at the end of the first wave train, it is quite incorrect to call the action illustrated by this curve a beat, since this can only exist when the wave form waxes and wanes a number of times.

Again, even though it were correct to so designate this action, it would still be incorrect to describe it as the object of the adjustment; since, as a matter of fact, it is merely an incident to the adjustment, which primarily is made for the purpose of getting the energy out of the closed circuit, and which results in the oscillations in the closed circuit being rapidly reduced to zero.

Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of page 94 of the work entitled "Wireless Telegraphy" by Zenneek, and requests that the same be marked "Claimant's Exhibit No. 242."

(Said exhibit marked as requested.)

Mr. Vaill: Also the sketch produced by Mr. Weagant as "Weagant Sketch No. 1" to be marked "Claimant's Exhibit No. 243."

Also photostat copies of pages 408 and 409 of "Robinson's Manual of Radio Telegraphy and Telephony," 1924 Edition, to be marked as "Claimant's Exhibit No. 244."

Also photostat copies of the first page of a certified copy of the File Contents of the application on which was issued patent No. 1,216,615, February 20, 1917, to George Seibt, together with photostat copies of five pages referred to by Mr. Weagant in answer to Q. 199, to be marked as one exhibit, "Claimant's Exhibit No. 245."

Also a copy of the drawing produced by Mr. Weagant as "Weagant Sketch No. 2," to be marked as "Claimant's Exhibit No. 246."

(Said exhibits marked as requested.)

[fol. 1255] Q. 200. Will you please consider the deposition of Major Joseph O. Mauborgne on behalf of defendant relative to his statements concerning the action of quenched gap transmitters, as found in answer to Qs. 10, 11 and 12, beginning on page 1215 of the Printed Record, and to Qs. 20 and 21, beginning on page 1252 of the Printed Record, and state to what extent your answer to the last question just made, applies to said testimony of Major Mauborgne. Please consider particularly the last part of Major Mauborgne's answer to Q. 12.

A. Major Mauborgne, in his answer to Q. 10, has testified in a manner similar to that of Mr. Loftin, relative to the use of loose coupling and close coupling in circuits

containing different types of gaps, but his statements in this regard have, I think, been completely answered by my answers to previous questions.

In answer to Qs. 11 and 12 he describes the manner in which what he calls the "Marconi transmitter" and the "quenched spark transmitter" are adjusted and calibrated for practical operation, and he states, (P. R., p. 1219), in connection with the quenched gap transmitter:

"What the operator really needs to know in this case is the adjustment he must make in order that when real quenching takes place in the gap a wave of a certain definite frequency in length, say 600 meters, will be emitted from the set."

Since it happens that I have personally tested and operated large numbers of radio transmitters which involved both the quenched spark-gap and the open type of spark-gap, I can say without any hesitation, that the procedure is identical in both cases.

I may also comment at this point on the fact that Major Mauborgne attempts to differentiate between the quenched spark-gap transmitter and the Marconi transmitter, although they are one and the same thing, and I have been obliged to assume in this answer that he was merely referring to two types of the Marconi transmitter, one involving the quenched spark-gap and the other involving the open spark-gap.

I will state further relative to the quotation just given, that I have never known an operator to adjust a set for the purpose of securing quenching. On the contrary, he adjusts the quenched spark-gap transmitter for the purpose of securing maximum antenna current and a clear note. Good quenching may be an incidental accomplishment of this adjustment, but it is not the main purpose.

Further, in discussing quenched spark-gap adjustment on Printed Record, page 1219, he states that the primary and secondary are more or less in tune, indicating to my mind that he recognizes that tuning is an essential in the operation of the quenched gap set.

After describing the adjustment of the primary and secondary circuits, he states that the coupling adjustment should be made, and then says, page 1219 of the Printed Record:

"This last adjustment may cause the primary and the secondary to be slightly out of tune with each other, as can be demonstrated by a measurement of the primary if the antenna and ground be disconnected."

In other words, in order to show even a slight mistuning, he removes the ground connection and the slight capacity [fol. 1256] effect due to it, which are actually there when the set is being operated, and constitute a real part of the primary capacity. I am personally more or less familiar with this effect and, instead of indicating that the circuits of the quenched spark-gap are out of tune, it proves rather the opposite; viz., that they are so exactly tuned that even a slight change of the capacities inherent in the structure and method of connection is sufficient to be noticed.

The same statement is made again by Major Manborgne in his answer to Q. 12, and so is answered by the remarks above.

In answer to Q. 20:

"Is there a resonant transfer of energy from the primary or lateral circuit to the secondary or antenna circuit in the quenched-gap type of transmitter, as, for example, the Wireless Specialty Apparatus type, Plaintiff's Exhibit No. 87?"

Major Manborgne states that there is no resonant transfer of energy from the local circuit to the open circuit, but that this transfer takes place by brute force, and not at resonant frequencies, since it is transferred from the local circuit to the open circuit by means of two frequencies.

Major Manborgne's statement is utterly untrue, so far as the transfer by brute force is concerned, since, were this the case, this transfer would be accompanied by great losses and would be highly inefficient; whereas, the actual use of the quenched spark-gap transmitter shows that the efficiency of transfer is very high, and his statement relative to the transfer by means of two frequencies, is based on a failure to understand the nature of the physical phenomena involved, and the fact that in the transference of energy from one circuit to another if the time-periods of two circuits are identical the oscillations in the two circuits execute their motions in the same time. The fact that the wave form is complex and may be analyzed into two or more

frequencies of the mathematical sort has no bearing on the question whatever, as I have already pointed out in my explanation in my previous answer.

Major Mauborgne also makes the statement that it is not necessary to adjust the product L and C in each circuit to be the same and this statement is directly contrary to the observations of practice and to the statements contained in the File Wrapper of the Seibt patent and the "Manual of Radio Telegraphy and Telephony" by Robison and Hooper, 1924 Edition.

He further states (P. R., p. 1232):

"* * * that beats between the two frequencies set up will assist in the operation of quenching out or preventing the further supply of energy from the local circuit to the antenna at the end of the first beat so that the energy may be radiated from the antenna at the predetermined frequency which is not the frequency of either of the two high-frequency oscillations by means of which the energy is transferred from the lateral circuit to the antenna."

He here refers to the two frequencies as though they were the cause of an effect, viz., the reduction to zero of the oscillations in the primary circuit; whereas, as a matter of fact, they are not the cause of anything in particular but merely mathematical components into which a particular type of wave motion may be analyzed, and they are, therefore, the result of its action, and not its cause.

[fol. 1257] His statement in this quotation relative to the transfer of the energy from one circuit to the other by means of these two frequencies is also incorrect in its inference, since it indicates a transfer resulting from motions of electricity which are not timed to correspond with the natural time-periods of the circuits. As a matter of fact, the actual oscillation, that is, the real physical thing, the actual motion of the electricity in the circuit, is timed to correspond with the natural time-periods of the circuits, and if it were not, the transfer of energy would be inefficient and ineffective.

In his answer to Q. 21 he states that the circuits of the Marconi patent 763,772 must be tuned and that the coupling must be the least possible; and third, that the spark gap must be of such a nature that the oscillations will be long drawn out.

In so far as his statement relative to tuning is concerned, Major Mauborgne is correct and is supported by the state-

ments of the Marconi patent 763,772, but his statements relative to the coupling are nowhere to be found in the Marconi patent, nor is there any limitation placed upon the type of spark-gap which shall be used therewith, of the sort which he makes in this answer.

I have already covered, in my answers to previous questions, the last two points of Major Mauborgne's answer and further explanation seems unnecessary.

Major Mauborgne further states (Printed Record, page 1233):

"If resonance between these two circuits did not exist, in other words, if the energy was transferred at two different frequencies, it would never be radiated at but a single frequency from the antenna."

and this quotation seems to me to be directly contrary to his statements on page 1232 relative to the quenched spark-gap, where he says:

"for in this case the energy is transferred from the lateral circuit to the antenna circuit at two frequencies, neither of which corresponds to the wave length emitted by the transmitter."

Q. 201. Will you please refer to the statements of Government officials or to statements in any Government publications, referring to the necessity and advantage of bringing the coupled circuit into tune, resonance or syntony?

A. I have ready, in answer to a previous question, referred to the "Manual of Radio Telegraphy and Telephony by Robison and Hooper" ("Claimant's Exhibit No. 244"), and to the statements on pages 408 and 409. There is also in the "Manual of Wireless Telegraphy (Radio) for the Use of Naval Electricians" of 1913, pages 162, 163 ("Plaintiff's Exhibit No. 78"), and 1915 Edition, pages 163 and 164, the following statements:

"The closed sending circuit should be in resonance with the open circuit and the coupling and decrement of the open circuit such as to afford the necessary selectivity to the receiving circuits with the best efficiency of radiation.

"Receiving circuits to receive from such a sender should be in resonance with each other and with the sending circuits and should have the same coupling as the sending circuits. The telephone diaphragm should be in resonance

with the wave train (alternator) frequency and with the operator's ear.

[fol. 1258] "As was previously stated, instead of designing telephone diaphragms for resonance with alternators, we designed the alternator for resonance with the telephone diaphragm or with the human ear.

"Resonance is thus seen to be a vital quality in wireless telegraph circuits. (1) Resonance of alternator frequency with primary sending circuit. (2) Resonance of primary circuit with secondary sending circuit. (3) Resonance of closed oscillating circuit with open radiating circuit. (4) Resonance of coupled receiving circuits with each other and with coupled sending circuits. (5) Resonance of telephone diaphragm with primary frequency. (6) Resonance of human ear with telephone diaphragm.

"Of these (1), (2) and (5) are elements of design and are not changeable at the will of the operator. (1) and (2) can be varied to a certain extent by reactance regulators which in some sets are provided for both circuits; but it is preferable to cover this feature in the original design of the transformers. (3) and (4) are entirely under the operator's control and on them the efficiency of the set depends."

In "Radio Telegraphy, U. S. Signal Corps," 1914, the Government Printing Office, 1914, pages 66 and 67 ("Plaintiff's Exhibit No. 90"), is found the following statement:

"When the adjustments of a quenched spark transmitter have been correctly made—that is, the circuits are in resonance, the coupling is right, etc.—a simple experiment will show that the primary current is a *minimum*; that is, the spark has been quenched and the primary current has been stopped quickly, as at the point Q of figure 53, and that at the same time the secondary current is a *maximum*; that is, it persists for a long time, as shown in figure 53. The experiment consists in making simultaneous readings of the currents in the primary and secondary oscillating circuits and plotting the readings for the different separations or couplings of the primary and secondary coils. This is shown in figure 57, where the scale at left is in amperes and that at the bottom is the separation of the two coils, the upper curve being for the primary and the lower for the secondary. At the point of correct coupling the primary

current was a minimum and the secondary or antenna current a maximum."

That the use of a quenched spark-gap does not avoid the desirability or necessity of adjusting the gap circuit into tune or resonant relation with the open circuit is further [fol. 1259] shown at page 105, at the bottom of the same exhibit, under the subject "Tuning of Sending Set":

"The tuning of the closed and open circuits to resonance, and the determination of the correct coupling between them are the two most important adjustments in a quenched spark transmitter."

Similarly in the 1915 edition of the Signal Corps book on Radio Telegraphy, at the bottom of page 107, and in the 1916 edition of the same work, at the middle of page 110, and particularly at the bottom of the page, "Plaintiff's Exhibit No. 92," are found the same statements.

In the Navy Manual, 1924 Edition, pages 539 and 540, is found the following statement:

"In no case should the antenna circuit be detuned—the utility and efficiency of the quenched spark system will be entirely lost."

In the Proceedings of the Institute of Radio Engineers, Volume I, Part III, is an article by Seelig and Van Derwoude on "The Sayville Station of the Atlantic Communication Company." Mr. Van Derwoude was the Engineer of the Telefunken Company, the German Company which built the apparatus installed in Sayville, and Mr. Seelig was the Manager of The Atlantic Communication Company.

On page 30, in speaking of the 30 K.W. transmitter and its two circuits, the article states:

"These two circuits, primary and secondary, must of course be in resonance or nearly so."

This particular station contained the largest quenched gap transmitter, I believe, which was ever built, and carried on communication with the German station at Nauen, which was also equipped with a similar transmitter. I personally inspected and examined this transmitter and observed it in operation and saw adjustments made in its

circuits, which indicated to me that they were in tune. I also saw the similar set in Nauen in operation.

Q. 202. In view of the references to tuning and sympathy in your last answer, will you please consider Mr. Loftin's statements regarding the use of the term "perfect tuning" in the Marconi patent in suit No. 763,772, as found near the bottom of page 1018 and the top of page 1019 of the Printed Record, and in the same connection Mr. Loftin's statements on page 1060 of the Printed Record, where he discusses Mr. Waterman's testimony regarding the preciseness or degree of tuning disclosed in the said Marconi patent and please state to what extent you may agree or disagree with Mr. Loftin regarding this matter. In answering this question, will you please indicate the conditions which determine the degree or exactness of tuning in the use of practical radio circuits?

A. The quotation by Mr. Loftin near the bottom of page 1018 of the Printed Record from the Marconi patent 763,772, in the matter of "perfect tuning," seems to be the basis for Mr. Loftin's criticism of Mr. Waterman's statement made near the bottom of page 153 of the Printed Record, and quoted by Mr. Loftin on Printed Record, page 1060, to the effect that no mathematically exact or precise equality of the circuits is realizable in practice.

The particular accuracy of tuning adjustment in the [fol. 1260] practical use of radio circuits is largely a matter of the electrical conditions obtaining in those circuits and Mr. Loftin is incorrect when he states that this adjustment is, of necessity, a very precise one.

Mr. Waterman, on the other hand, is entirely correct when he states, in the quotation referred to, that it is important to the efficient transfer of energy that this equality and (the product of the inductance and capacity of the two circuits) should be approximately or substantially obtained.

When two radio circuits are tuned and coupled together, the tuning condition may be that which is termed "sharp tuning" or it may be that which is termed "broad tuning," depending upon the amount of resistance in the circuit. "Perfect tuning" in the exact mathematical sense, is unattainable in practice, and the use of this term in the patent is, in my opinion, intended to mean the best tuning practically obtainable. Marconi is an extremely practical man,

and it is inconceivable that he should use an expression of this kind in any theoretical or mathematical sense. The exactness with which a circuit can be tuned is dependent upon two things; first, the total amount of resistance in the circuit and, secondly, the wave form of the applied electromotive force. If the circuit resistance is zero and the applied electromotive force is of the simple harmonic form, which I have previously described; that is to say, if it is one frequency in the strict mathematical and technical sense, then the tuning of the circuit will be perfect.

Under these circumstances the ratio of the current flow in the circuit, when tuned to the current flow when detuned the slightest imaginable amount, would be infinite. This, however, is a condition of affairs quite unrealizable in practice, since all electrical circuits have resistance and often quite a large amount of resistance.

If an electrical circuit has a relatively small amount of resistance, it is said to tune "sharply", and this fact is indicated by a large change in the current flow when it is slightly mistuned. If such a circuit contains a relatively large amount of resistance, then it is said to be "broadly" tuned, and this means that the inductance or capacity of the circuit may be changed an appreciable amount from the exact values indicated by theory, with a resulting slight or negligible change in the current flow in the circuits.

Both types of circuits are encountered in practice, consequently the preciseness of tuning required between the tuned coupled circuits of a radio transmitter or receiver is a variable quantity and one which can be stated with definiteness only as the result either of actual tests or calculations based on exact knowledge of all the conditions.

Examples of "sharply tuned" circuits and "broadly tuned" circuits used in practical radio apparatus are found in both the transmitting sets and the receiving sets. If a transmitter is coupled to the antenna of a ship which has the very good earth connection provided by the salt water, the antenna resistance in general will be relatively low, and the circuit tuning fairly "sharp." On the other hand, if the transmitter be coupled to some shore station antennae, relatively high resistance will be encountered, and the tuning will be relatively "broad." Similarly in receiving sets, if a detector is used which inserts a negligible resistance into the circuit and the coils and condenser of

the secondary circuit are well made and have small resistance, this secondary circuit will be sharply tuned, and this is the case of a modern receiving set with a three-electrode vacuum valve for detector.

If, in such a receiving set, the detector is one which introduces a large resistance into the tuning circuit, the tuning will be relatively "broad" and a considerable departure in adjustment from the exact tuning point is permissible without appreciable loss in effectiveness. Such a detector is the crystal detector, and it is very common to provide the circuits of a receiver or, rather, the secondary circuit of a receiver used with the crystal detector, with relatively rough adjustments, due to the facts just outlined.

Referring now to the statement of Mr. Waterman at the bottom of page 153 of the Printed Record, which statement is quoted by Mr. Loftin on page 1060 of said record, and to Mr. Loftin's criticism of this statement, I will again express the opinion, based on the facts outlined above, and a long experience with them in practice, that Mr. Waterman correctly presents the matter of precision of adjustment of tuned circuits, while Mr. Loftin incorrectly represents it.

Q. 203. In answer to Q. 26 of Defendant's testimony, Mr. Loftin criticises Mr. Waterman's Sketch No. 3 inserted opposite page 155 of the Printed Record. Will you please consider Mr. Loftin's answer on page 1062 of the Printed Record and state in what respects you agree or disagree with him?

A. I disagree with Mr. Loftin's statement relative to Mr. Waterman's Sketch No. 3, opposite page 155. The function of the condenser j^3 in Fig. 2 is to provide a means of connecting the associated battery circuits to the secondary of the receiver circuit in such a way that no interruption is caused to the flow of electrical oscillations around through the circuit g^2, j^2, g^2, h' , while at the same time the battery current can flow through g^2, j^2, g^2 , coherer T, back to the battery B and the indicating mechanism R. The insertion of the condenser j^3 at the point shown in Fig. 2 permits of this action without the short-circuiting of the battery, while at the same time offering a negligible impedance; this is to say, opposition, to the flow of the oscillating current.

If the value of j^3 is large, then so far as the tuning of the circuit is concerned, it is without effect, and may be considered as the equivalent of a short-circuit. If the

value is small, then it would have some effect on the tuning, but merely the effect of requiring a different value of h' for a particular wave length, a difference of which the operator using the set would not be conscious.

When inserted in the position shown in Waterman Sketch No. 3, condenser j^3 functions in a way similar to that in which it functions in the location shown in Fig. 2 of the Marconi patent 763,772, viz., it permits the introduction of the battery circuit and indicator circuit into the receiver circuit in such a way that the direct current can pass through the detector T and the indicating mechanism R receive the direct-current impulses; that is to say, the rectified oscillations.

As will be noted from diagram, Waterman Sketch No. 3, the battery current starts at battery B, flows through coil C', detector T, inductance q^2 , inductance j^2 , inductance q^2 , coil C'', indicator R, arriving back at the battery again. This battery is not short-circuited, due to the insertion of the condenser j^2 , so that in this respect it operates in the identical manner in which it operates in Fig. 2.

[fol. 1262] In the location shown in Waterman Sketch No. 3 it is outside of the oscillating circuit q^2 , j^2 , q^2 , h' and, therefore, does not interfere with the flow of the oscillations in this circuit. It cannot, in the position shown in Waterman Sketch No. 3, appreciably affect the tuning; whereas, in the location shown in Fig. 2 of the Marconi patent No. 763,772, it can affect the tuning, but it does not matter the slightest if it does, since the result is one of which only the designer of the arrangement and not the user would be conscious.

The two locations of condenser j^3 are the complete equivalents or alternatives, and it does not matter the slightest, practically, which one is actually used, except that from the standpoint of construction, that of Waterman Sketch No. 3 is more convenient.

Q. 204. Mr. Loftin, in answer to Q. 27, * * * refers to the following United States Patents:

Hutin and LeBlanc, No. 838,545, dated December 18, 1906 (Filed May 9, 1894).

Pupin, No. 519,347, dated May 8, 1894.

Pupin, No. 640,516, dated May 28, 1895.

Stone, No. 638,152, dated November 28, 1899 (Filed December 15, 1896).

Will you please consider these patents, point out what they disclose, and what bearing, if any, they have upon the Marconi four-circuit tuning patent No. 763,772, so far as relates to the combination of elements referred to in the claims in issue, and their mode of operation and results, giving your reasons for any opinion you may express?

A. The patent to Hutin & LeBlanc discloses, as its title indicates, a patent for a system of multiple telegraphy and telephony and has nothing whatever to do with a radio telegraph system.

Fig. 6 of this patent indicates schematically the general idea the inventor had in mind, which was that of affecting a number of different telegraph stations, all connected to the same line, by the employment of different frequencies for the purpose of transmitting and some circuits having inductance and capacity so adjusted as to pick out one of the frequencies from the line. The patent contains some theoretical statements relative to the relation between frequency, current flow and circuit constants, which indicate that the inventor was familiar with the underlying principles of alternating current phenomena which, of course, were well known prior to the date of the application for this patent.

I fail to find any disclosure in this patent which has any bearing on a radio communication system, or any information which would be useful to one working in the radio art, except the scientific principles referred to, a statement of which could be found in any text-book dealing with the subject of alternating currents.

Patents Nos. 519,347 and 640,516, issued to Pupin, are similar in their disclosures to the Hutin & LeBlanc patent, just described, and deal with apparatus for the transmission of electrical variations over line wires.

In patent No. 519,347, Pupin shows how the inductance of a transformer may be neutralized by the use of capacities and telephonic or telegraphic communication may be improved.

In patent No. 640,516 there is disclosed a system involving [fol. 1263] a plurality of transmitters of different frequency and a plurality of receivers connected in circuits, so adjusted as to be in resonance with the line circuit. I fail to find any disclosure in this patent which has any bearing on a radio communication system, or which is in any way related to the Marconi patent 763,772.

The statements contained in the patent relative to resonance are merely the statements of the well-known principle governing the action of alternating currents in circuits having inductance and capacity therein.

Patent No. 638,152, issued to J. S. Stone, is another system of wire communication whose purpose is to permit the simultaneous transmission over a wire line of several signals simultaneously. Resonant circuits are employed at the transmitter and at the receiver for this purpose.

I do not find that there is any disclosure in this wire system or anything which is of consequence in its bearing upon Marconi patent 763,772, nor anything particularly useful to a worker in radio, but merely the employment of some resonant circuits in a wire communication scheme.

Q. 205. Will you please consider Mr. Loftin's statement regarding the Marconi Re-issue patent No. 11,913 and the Marconi patent No. 763,772 and state briefly the differences between the means for tuning shown and described in the Marconi Re-issue patent and that shown in Marconi patent No. 763,772, giving an explanation of the differences in results obtained in each instance.

A. Marconi, in the Re-issue patent, discloses as his only means of tuning one station to the other, the adjustment of the length of the antenna. No independent adjustable units, such as inductance or capacity, are described or illustrated in this patent.

In Marconi patent No. 763,772 means for completely and conveniently tuning both the transmitter and the receiver are described.

Referring to Fig. 1, in the antenna circuit there is a variable inductance g , and in the closed circuit there is a variable condenser c . By the use of these variable elements the open radiating circuit and the closed reservoir circuit are readily brought into accord.

In Fig. 2, the open antenna circuit is provided with a convenient adjustable tuning means, indicated as the variable inductance g' , and an additional variable tuning means in the condenser b . In the secondary circuit, the inductance coils g'' are variable, and enable an operator to readily adjust the time-period of this circuit to accord with the time-period of the antenna circuit. The variable condenser

h' is an additional means in this same circuit and, in general is preferred in practice over the variable inductances g^2 as the means of tuning this circuit.

It appears, therefore, that Marconi patent No. 763,772 discloses the necessary means for readily adjusting each and all of the four circuits to the same time-period.

Mr. Loftin discusses Mr. Waterman's statement and states that Mr. Waterman's views as expressed therein, correspond to his own, to the effect the Marconi patent now under discussion was in no way responsible for the principles of resonance. The statement of Mr. Waterman referred to by Mr. Loftin is as follows:

[fol. 1264] "Thus this idea of resonance between local circuits in the Marconi second or tuning patent is an entirely different thing from the interstation tuning, referred to in the first Marconi patent and the Lodge patent, but it is a means which, while increasing the energy and the distance of signaling, possible with antennae of given dimensions, also improves and facilitates interstation tuning.

"In the first Marconi patent and in the Lodge patent there is one circuit at the transmitting station and one circuit at the receiving station tuned to agree with the transmitter. In the arrangement of the second Marconi patent there are two circuits tuned to resonance with one another at the transmitting station and two circuits tuned to one another at the receiving station, these circuits being also tuned to the wave length emitted by the transmitting station."

I consider the statement made by Mr. Waterman to be a very fair and correct statement of the difference between the Marconi tuning patent, that is, No. 763,772, and the first Marconi patent, that is, the Re-issue patent No. 11,913.

Mr. Loftin's conclusion that the tuning patent was in no way responsible for the principles of resonance seems to me to be entirely inapplicable and without any significance which I am able to understand. A patent could hardly be responsible for the principles of resonance, since these were established by nature. Their discovery and exposition has resulted from the work of scientific men, and these principles are not matters usually disclosed in a patent, or which can be covered by Letters Patent.

He further states, at the top of page 1068 of the Printed Record:

"There appears to be no contention that Mr. Marconi put resonance in radio, but I understand Mr. Waterman's summary to mean that it is merely contended that Mr. Marconi added to existing resonance systems a couple of steps that would work better under resonant conditions."

This is a conclusion which appears to be entirely unjustified by anything which Mr. Waterman has stated and which is most certainly contrary to the facts.

Marconi Re-issue patent No. 11,913 disclosed to the world the first practical radio-communication system, and resonance or tuning is part of this disclosure. Lodge improved on this original disclosure of Marconi by the inclusion of his variably acting inductance coil, and Marconi very greatly improved radio-communication systems by his disclosures of his tuning patent No. 763,772 and made an extended use of the principle of resonance when he tuned four circuits to the same time period.

Mr. Loftin further states that Mr. Waterman has neglected to include in his statement any reference to the matter of coupling, and goes on to say that there can be no resonance unless coupling conditions are specified. This is a statement with which I am in complete disagreement. Resonance between two circuits exists when the time-constant, that is, the product of the inductance and capacity in the two circuits is the same, regardless of what coupling may exist.

Mr. Marconi directs that his circuits should be in resonance, [fol. 1265] but he says nothing *in words* about coupling, disclosing, however, in his structures, that coupling may be a widely variable quantity.

In my discussion of the quenched-gap circuit I have referred to a number of references in the File Wrapper relative to the matter of resonance between the circuits of this type of transmitter. In one of these, contained in Paper No. 22, Amendment E, received July 18, 1913, page 22, "Claimant's Exhibit No. 245," is the following statement:

"Applicant puts the two circuits in tune and then determines the best coupling, looking at the needle of an indicating instrument. The tuning depends on the capacity and self induction and not on the coupling."

This statement, which is in accord with the remarks I have just made, expresses the facts relative to resonance between electrical circuits in the manner which I have always understood them, and which I believe to be the understanding of men in general skilled in this particular art. In fact, I am unable to recollect ever having read or heard the statement that coupling was involved in the matter of resonance between two circuits, prior to reading Mr. Loftin's deposition.

Mr. Loftin states that his view in this respect is in accord with the art, and in particular with Mr. Marconi's own view, as expressed by him in an address before the New York Electrical Society, and from which Mr. Loftin quotes the following:

"These two circuits are tuned so as to have approximately the same natural period of electrical oscillation. They then—like tuning forks—have been adjusted in syntony. It is well known that when using an ordinary spark discharge in the primary circuit, unless weak coupling is employed, the oscillations set up in one circuit create oscillations of two frequencies in both circuits. This has the disadvantage that the radiated energy becomes divided between two waves of different length, and if the receiver is tuned to only one of these wave lengths, it will utilize or absorb only part of the energy reaching the receiver—the energy of the other wave being lost."

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This quotation does not appear to have any bearing whatsoever on the matter referred to by Mr. Loftin. While it indicates a recognition on the part of Mr. Marconi of the well-known fact that if two circuits are coupled together too closely, a complex wave form will result which is analyzable into two frequencies, it nowhere states that the two circuits depend on any particular value of coupling, in order that they may be in tune.

[fol. 1266] I therefore fail to find in this quotation any support whatever for Mr. Loftin's contention that resonance depends upon coupling.

Mr. Vaill: Counsel for claimant offers in evidence "Proceedings of the Institute of Radio Engineers," pages 23 and 30, referred to by the witness in answer to Q. 201, and

requests that the same be marked "Claimant's Exhibit No. 247."

(Said exhibit marked as requested.)

Q. 206. Please consider "Loftin Sketch M" opposite page 1071 of the Printed Record, and state whether you agree with Mr. Loftin's consideration of the action of the circuits illustrated therein, as concerns Marconi Patent 627,650 ("Defendant's Exhibit B-6").

A. Mr. Loftin's statements relative to "Loftin Sketch M" are quite incorrect and at variance with the disclosures of the Marconi patent No. 627,650.

The coil j of "Loftin Sketch M" is not shown variable in the Marconi patent, but is shown as a fixed coil. Mr. Loftin further states that the following quotation from page 1072 of the Printed Record:

"The capacity of the condenser on the connection between the imperfect contact and the secondary of the coil should be varied (in order to obtain best effects) if the length of wave is varied."

is a definite instruction to vary the time-period of the secondary circuit of the receiver. Inspection of the diagram shows that condenser K is in series with inductance j^2 and detector T and, due to the perfectly well-known fact that the resistance of detector T is relatively high, a condenser connected in the position shown at K is totally incapable of tuning the receiving circuit and it seems to me incredible that Mr. Loftin should not be aware of this fact.

In order for condenser K to tune with inductance j^2 , that terminal of the condenser K which goes to the detector T, should go to one terminal of inductance j^2 through a connecting path which does not contain a high resistance. Totally aside from the question of theory involved, I may say that I have actually set up the circuits shown in "Loftin Sketch M" and can state positively, as the result of practical observations, that condenser K does not tune.

The action referred to in the patent and quoted by Mr. Loftin, is merely the ordinary action of what is known as the "stopping condenser." The purpose of condenser K is to stop the flow of the battery current from Battery B, through the inductance j^2 , which would short-circuit the battery and prevent potential being applied to detector T. Oscillating current does not flow through condenser K, but the recti-

fied half cycles of the oscillating current, which are all in one direction.

As the wave length becomes longer, the time consumed by each pulse becomes longer, its rate-of-change slower and, consequently an increase in the value of the condenser K allows these pulses to flow more readily. This change, however, is a slow one; in practical operation is totally unlike that of the adjustment of the tuning condenser and, in fact, for all practical purposes may be omitted entirely, condenser K being fixed in value, since the advantage obtained as the result of any adjustment is so small as to be inconsequential.

I have no hesitation, therefore, in stating positively that [fol. 1267] Marconi patent No. 627,650 does not disclose tuning in the secondary circuit, and does not disclose any means for tuning the secondary circuit.

The statement of the patent itself (Page 1, lines 31 to 37):

"It is desirable that the induction-coil should be in tune or syntony with the electrical oscillation transmitted, the most appropriate number of turns and most appropriate thickness of wire varying with the length of wave the oscillation transmitted."

is perfectly clear in this respect, and indicates that, in accordance with the knowledge of the art at that time the antenna system should be in tune with the incoming waves. Had Marconi had the slightest thought at this time of tuning the secondary circuit, he would unquestionably, in my opinion, have stated in his usual explicit manner, that such was his intent and, furthermore, in accordance with his practice of giving detailed instructions in the matter of actual structure, would have specified the necessary coil and condenser arrangement for the carrying out of his purpose.

There is, however, no information of this nature to be found anywhere in this patent, and I recollect that in some of Mr. Marconi's testimony he has positively stated that the idea of tuning had not yet occurred to him. On Printed Record, pages 557 and 558, where the testimony of Mr. Marconi was stipulated into this case, occurs the following:

"Q. In your patent 627,650, you say, at page 1, line 32:

"It is desirable that the induction-coil should be in tune or syntony with the electrical oscillation transmitted."

Notice the words 'the induction-coil in tune or syntony.' What does that mean, except that the two members of the induction have the same time period?

"A. It does not mean that there, at least I do not think it does, because I didn't know it at the time that this specification was filed.

"Q. What is that date?

"A. That date was the 5th of January, 1899.

"Q. In 1899 you didn't know it?

"A. I didn't know that it was necessary to tune the two circuits of the receiver or transmitter in order to attain those effects."

Q. 207. Will you please refer to Marconi patent No. 647,007 ("Defendant's Exhibit C-6"), Marconi Patent No. 647,008 ("Defendant's Exhibit D-6"); Marconi Patent No. 647,009 ("Defendant's Exhibit E-6") and Marconi Patent No. 668,315 ("Defendant's Exhibit F-6"), briefly stating what they refer to in the radio art and also whether they disclose, either in the specifications, or drawings, the requirement that open and closed circuits of a transmitter or receiver are intended to be tuned so as to be in resonance with each other, giving your reasons for your opinion?

A. Marconi patents referred to in your question all refer to particular kinds of coil construction usable in the circuits of the prior Marconi patents.

Patent No. 647,007 refers, lines 15 to 25, page 1, to the fact that the coils of the previous patent, 627,650, consisted of single layers, while those of the patent under discussion consist of a plurality of layers and sections wound in a particular way.

[fol. 1268] A diagram of connections for employing these coils is shown in Fig. 1.

Patent No. 647,008 is also directed to a coil of multiple layer construction and the connection of the end of the secondary coil which is farthest away from the nucleus or axial line of the coil, direct to the sensitive tube and not through a condenser.

Patent No. 647,009 is also directed to a particular type of coil construction and a direct connection to the sensitive device.

Patent No. 668,315 discloses a method of connection of the battery and indicating mechanism to the secondary coils and detector, which involves splitting the secondary

coil in the centre, inserting a condenser therein and attaching the battery circuit to the two sides of the condenser; this is the method of connections employed in Fig. 2 of the tuning patent 763,772.

All of the patents above mentioned are merely for coil constructions and details of connection, and they do not, in any way, disclose anything in the matter of tuning between the closed circuits and the open circuits.

Q. 208. Please consider the Lodge patent No. 609,154 and state what, if any, bearing it has upon the invention of the Marconi four-circuit tuning patent No. 763,772, particularly as concerns Figs. 4 and 13 of the drawings and Mr. Loftin's "Sketch L" (opposite page 1069 of the Printed Record), pointing out to what extent you may agree or disagree with Mr. Loftin in his statements regarding the disclosure of said Lodge patent with reference to the claims of Marconi patent No. 763,772, giving your reasons for your answers.

A. Mr. Loftin, in his "Sketch L," in drawing the circuits for Fig. 4 of the transmitter, has omitted the spark-gap in the antenna circuit shown in Fig. 4. He described the action of this Fig. 4 of the Lodge patent in language taken from the patent itself, and which is descriptive of Lodge's idea of charging the antenna circuit by what he terms "impulsive rush."

This idea of Lodge's was a very beautiful conception but, unfortunately, the apparatus disclosed in Fig. 4 is incapable of functioning in this manner, a fact which is readily evident to one skilled in the art from a simple inspection of the circuits and spark-gaps employed. In order to carry out this thought in any manner whatsoever, the spark-gaps b^6 and b^7 of the patent would have to cool so rapidly that they would be extinguished after the first half oscillation of the condenser circuit. No spark-gaps have ever been constructed and used commercially which are capable of cooling with this degree of rapidity. If, in Fig. 4, the coil k is constructed in accordance with any information to be found either in the specification or the drawing, Fig. 4 is totally inoperative, for the reason that the coil k short-circuits the condensers, so that any oscillations taking place in the circuit containing the condensers are unable to get into the antenna.

If the coil k is omitted the figure will operate, but in a way which is anything but the manner described by Lodge. In the first place, it is inefficient and less effective than

the original Re-issue Marconi patent No. 11,913, and in the second place, instead of omitting a single pure wave train, it gives rise to a complex wave train analyzable into two rather widely-separated frequencies. In the light of these facts I consider that Fig. 4 of the Lodge patent has not disclosed anything in the way of a transmitter capable [fol. 1269] of rapidly transferring energy from a closed circuit to an open circuit, and allowing the open circuit to oscillate in its own free way.

I find no basis whatever, for instance, for Mr. Loftin's contention that this figure discloses the principle of the quenched gap system.

In Mr. Loftin's "Sketch L, Lodge Receiver" taken from Fig. 13 of the patent, he shows a condenser *w* in parallel with the telephone and contends that this is a means for tuning and that its inclusion by Lodge is a direction to tune this circuit. Nothing that I can think of could be further from the facts disclosed by the Lodge patent. In the first place, this condenser is so connected in the circuit that it is in series with the detector and the inductance and, as was the case in "Loftin Sketch M" of Marconi patent 627,650, a condenser when so located is incapable of tuning the circuit.

In commenting upon this condenser, Mr. Loftin quotes, lines 62 to 68, page 4 of the patent as follows:

"In all cases it is permissible and sometimes desirable to shunt the coils of the telegraphic instrument by means of a resistance or a capacity, as shown at *w* in Figure 12, in order to connect the coherer more effectively and closely to the capacity areas or receiving arrangement whereby it is to be stimulated."

and it is to be noted that the quotation states that either a resistance or a capacity may be used for the purpose of shunting the telegraphic instrument.

Now, it is a matter of elementary knowledge that electrical circuits may be tuned by an inductance or a capacity; whereas resistance not only is incapable of effecting any tuning action, but is actually detrimental in circuits which are tuned, and is excluded in practice as much as possible. It is therefore inconceivable to me that so able a scientist as Lodge could have been thinking of tuning, and in the same breath specify capacity or resistance as alternative means for accomplishing the purpose.

It is further perfectly obvious from the specification of the Lodge patent and the invention disclosed therein of the variable inductance, that if Lodge had had any thought of tuning his secondary circuit he would have described carefully and in detail the way to do it, and the purpose for doing it, which he did not.

Q. 209. Has the transmitter illustrated in Fig. 4 of the Lodge patent No. 609,154 and described in the specification thereof, ever been practically used by the claimant herein or, as far as your knowledge and experience goes, by the British Marconi Company, or anyone else? If not, please state, according to your understanding and knowledge of the matter, the reasons why the Lodge transmitter of Fig. 4 has not been used practically. In answering this question you may refer to any tests that have come within your knowledge as indicating the action of transmitters similar to those of the Lodge patent.

A. No practical use of the Lodge Fig. 4 of sufficient consequence to come within my notice has even been made, and there are perfectly good technical reasons which have been brought out in tests of the Lodge Fig. 4 with which I am personally familiar, why it has not.

During the Kilbourne & Clark case the apparatus of Fig. [fol. 1270] 4 of the Lodge patent was set up and operated by the Expert for the defense, Mr. Pickard, and practically all of the facts of operation were brought to light. I personally witnessed a large number of tests on this apparatus, some of which were made at my suggestion. As set up by Mr. Pickard, the coil *k* was constructed with an iron core, a construction nowhere disclosed in the patent and quite contrary to the usual practice when coils are used for the purpose of carrying high-frequency currents. On substituting for this coil one made as nearly as possible like the disclosure of the patent, the device was found to be entirely inoperative. Following this, various other coils *k* were constructed, having different values of inductance, and their effect on the operation of the set observed. It was found, on making measurements of the current in the antenna that the wave length radiated was not, as should have been the case, if the device were operating in accordance with Lodge's "impulsive rush" idea, a pure wave but, on the contrary, the wave form was found to be a complex one and indicated two wave lengths in the antenna

circuit, which wave lengths varied with the construction used in the coil k .

These observations were of fundamental importance and significance, since if the circuit were operating as described by Lodge, in the "impulsive rush" fashion, not only would there be a single frequency in the antenna, but the coil k or any other electrical element in the charging circuit could not have any effect on the wave length, since, under Lodge's idea of things, the charging circuit would be cut off, while the antenna was oscillating in its own natural way. The fact that it did not do so, that the wave form was complicated and that the change of coil k changed this wave form, is conclusive proof, technically, that the device was not operating on the basis of "impulsive rush" charging, and no more conclusive technical proof of this fact could possibly be obtained.

A most interesting point in connection with the tests on this apparatus was the fact brought out in the first test demonstrated by Mr. Pickard, in which wave lengths of 324 meters and 1,010 meters were radiated. I remember being curious at the time as to just where these widely-separated wave lengths were coming from, and I noted that the 324-meter wave length was much the stronger. In a subsequent test I found that the coils b^4 , b^4 of the patent which, under the Lodge theory of operation, should be controlling in the wave length produced could be disconnected entirely from the circuit and a wave length of 324 meters, viz., the principal one when two are being radiated, was still being radiated, showing that it was the wave length of the antenna circuit down through condensers j and the coil k to ground; a most astonishing discovery relative to the operation of a device supposed to be radiating in accordance with the natural mode of vibration of the antenna system when taken alone.

Additional interesting facts were noted relative to the operation of the spark-gaps b^6 and b^7 . If there is anything whatsoever in the Lodge idea of "impulsive rush" charging, it is that spark-gaps b^6 and b^7 , after throwing the energy into the antenna system, immediately open up and allow the antenna to oscillate in its own free way. This is what Lodge believed that they were doing, and this is the action which he ascribes to them in his patent, but in the tests above referred to on the actual apparatus [fol. 1271] shown and described in Fig. 4 of the Lodge

patent, the spark-gaps h^6 and h^7 could be closed up; that is to say, so adjusted that no spark-gap existed any longer but a metal-to-metal contact, without any appreciable change in the action of the system.

There is no more conclusive test possible than this test as to whether or not the spark gaps h^6 , h^7 are serving any useful purpose; that is, are enabling energy to be transferred in an impulsive rush to the antenna system, and the results of the tests show, beyond a shadow of doubt, that the apparatus of Lodge Fig. 4, as arranged by Mr. Pickard, and with some alternative modification, did not function in the way which Lodge thought it did; that is, on the basis of transferring energy with an impulsive rush to the antenna system.

Still further light was thrown on the action of these circuits by a comparison with the simple arrangement of the Re-issue patent No. 11,913 to Marconi, using the same induction coil to supply the power, and the comparison shows that the original Marconi arrangement was materially more efficient. This, again, is most pertinent to the question of "impulse charging" since, were the latter actually taking place in the Lodge Fig. 4, the efficiency of the arrangement should be materially greater than that of the simple Marconi arrangement. Actually, however, it was less; when, in a modern quenched spark-gap transmitter we actually succeed in transferring energy relatively rapidly from the closed circuit to the open circuit, this increase in efficiency is one of the important results, although this method is still a long way from the "impulsive rush" idea, but not an accomplishment, of Lodge.

Summing up my knowledge and experience gained from actual tests of apparatus arranged as in Lodge Fig. 4, together with my study of the theory of operation involved, I may state that this arrangement is entirely useless, is about one-half as efficient as the original re-issue arrangement of Marconi, and does not operate on the basis of "impulsive rush."

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As I have already pointed out in my discussion of the question of "impulsive rush" charging or, as it is sometimes termed, "impulse charging," no system embodying this idea has ever been developed which has been appreciably successful in finding extensive commercial use.

Laboratory experiments, however, have been conducted in order to determine the nature of the actions involved when true impulse excitation was secured.

A report of an experimental investigation of this subject is found in the "Proceedings of the Institute of Radio [fol. 1272] Engineers," Volume 8, 1920, page 75. A paper by John H. Morecroft, Associate Professor of Electrical Engineering at Columbia University, gives, in Fig. 1, an arrangement of electrical circuits adapted for the production of an electrical impulse and an oscillating circuit excited by the impulse. As is stated in the paper, an oscillograph is connected to that part of the circuit which produces the impulse, and another one to that part of the circuit in which the resulting oscillation takes place. The oscillograph is a device which is capable of giving a picture in the form of curves of the actual motion of electricity in a circuit.

In Fig. 1 is a battery B , switch S , a resistance R , and a second resistance not lettered, but shown between two wires a, b . When the switch S is closed, current flows through the circuit mentioned and an electromotive force is produced across the terminals of the two resistances. The electromotive force induced at the point a, b operates the oscillograph, while the electromotive force produced across resistance R , charges the condenser C which, when it discharges through the circuit C, R, L, R' , gives rise to an oscillatory current, due to the presence in this circuit of the inductance L .

Across the terminals of resistance R' is connected a second oscillograph to the wires c, d , which gives a picture of the electrical motion in this circuit. The switch S is so constructed mechanically as to be able to make a contact lasting between two one-thousandths of a second and any longer time desired.

Various oscillograms are shown in the paper, which illustrate in a very clear and fundamental way, what takes place under conditions of "impulse charging." In Fig. 2 • • • (part of Claimant's Ex. 248) will be seen two curves, the upper one representing the "pulse" which, as will be noted, rises almost perpendicularly, has a slight curve at the top, and falls in the same practically instantaneous manner.

The lower curve represents the oscillations taking place in the oscillating circuit and shows an oscillation which starts with a maximum amplitude and decreases to zero.

As will be seen, there is a marked contrast between this curve and the curves representative of the action in quenched spark-gaps such, for instance, as shown in the "Manual of Radio Telegraphy and Telephony" by Robison and Hooper, 1924, page 408, Figs. 272 and 273 ("Claimant's Exhibit No. 244").

In Fig. 272, representative of the action in the exciting circuit, it will be noted that there are a number of complete oscillations, a number which, as a matter of fact, is considerably less than usually exists in practice. This is in contrast to the single pulse of the upper curve of Fig. 2 of Morecroft's paper.

In Fig. 273, "Claimant's Exhibit No. 244," the secondary oscillations are seen to increase in value up to the point where the primary oscillations cease entirely, while in Fig. 2 of the Morecroft paper the oscillation rises to maximum value at the start, and falls off thereafter.

In Fig. 3 of the Morecroft paper a pulse is shown in the upper figure, which occupies a longer time than that of Fig. 2, and this is indicated by the fact that the distance between the two vertical sides of the pulse is longer.

Under these circumstances the second oscillation is slightly greater than the first, and Mr. Morecroft has, in [fol. 1273] Figs. 3 and 4 (part of Claimant's Ex. 248), page 77, plotted two curves, one of which shows the variation of the first swing in the oscillating circuit with the duration of the pulse, while the other curve shows the variation of the second swing with the duration of the pulse. These curves bring out the fact that the amplitude of the first swing or alternation does not change after the pulse has a length equal to one-quarter of a cycle, while the amplitude of the second one is a maximum when the pulse length is equal to one-half the natural period of the oscillating circuit, after which time it decreases in amplitude.

The effect of the variation in the length of the pulse is due to the following: If we examine the curve illustrative of the pulse in any of these figures, we find that the rise and fall are very nearly vertical, while the top is either slightly curved, as in the short ones, or nearly flat in the longer ones. The effect produced by the pulse on the oscillating circuit takes place during this rapid rise and rapid fall, while *while* nothing at all happens during the period represented by the flat part of the curve.

When the rise takes place in the curve illustrative of the pulse the action in the oscillating circuit starts; that is to say, the oscillating circuit is given a "kick" which can be represented by the mechanical analogue of striking a pendulum bob with a hammer. When the pulse falls again, it gives another "kick", which will either assist or retard the current flowing in the oscillatory circuit, depending on whether or not it occurs when the electricity in the circuit is moving in the same direction as the "kick".

Fig. 3 of the Morecroft paper illustrates the case when the impulse, due to the falling of the pulse, occurs at the right time to help the oscillations in the oscillating circuit, thereby making the second alternation greater in amplitude than the first.

In Fig. 5 (part of Claimant's Ex. 248) a case is shown in which the impulse occurs at the wrong time, catches the second alternation before it is complete, turns it around, and makes it start all over again, thus destroying, instead of assisting, the motion.

Each "pulse" in these figures is in reality two pulses, one represented by the rise and the other represented by the fall. The reason that this particular situation exists lies in the fact that it is extremely difficult, if not impossible experimentally, to produce a single pulse which would be represented by a single vertical line in the oscillogram.

It can be deduced, however, with absolute certainty from the experiments recorded in this paper of Morecroft's that if a single ideal pulse could be produced, the resultant train of oscillations in the oscillating circuit would always start at a maximum and slowly fall off.

No action such as is shown and described in this Morecroft paper is obtainable with the Lodge Fig. 4 arrangement and no apparatus is disclosed which is capable of being used in any way to produce such results as these. Furthermore, as is very evident from a mere inspection of the curve such as those of "Claimant's Exhibit No. 244", the quenched spark gap arrangement does not function on the basis of impulse excitation, but requires the transfer of energy from the closed circuit to the open circuit during a period which is very long compared to that of impulse excitation, involves several oscillations in the primary circuit and a resonant relation between the circuits.

[fol. 1274] The Lodge Fig. 4 circuit not only does not employ the impulse method of excitation, but also does not

employ the tuned coupled-circuit method of energy transfer. It was intended for the purpose of impulse excitation, but possessing none of the requirements of this method, it falls into the category of unsuccessful and misconceived experiment, unless for any purpose other than an instruction as to what not to do in a radio transmitter.

Mr. Vaill: Counsel for claimant offers in evidence a printed copy of the article entitled "An Experiment on Impulse Excitation" by John H. Morecroft from the "Proceedings of the Institute of Radio Engineers", Volume 8, 1920, Issue No. 1 (February), pages 75 to 84, inclusive, and requests that the same be marked "Claimant's Exhibit No. 248".

(Said exhibit marked as requested.)

Q. 210. Referring further to your answer to Q. 208, in which you considered Figs. 12 and 13 of Lodge patent No. 609,154 and "Loftin Sketch L", will you please refer to any additional information you may have indicating what Lodge may have had in mind in referring to the resistance " w " of Fig. 12?

A. In a work entitled "Signaling Through Space without Wires" by Oliver Lodge, 3rd Edition, Mr. Lodge described some of the arrangements of his patent No. 609,154, and on page 52 (Claimant's Ex. 249), Fig. 25, he illustrates Fig. 13 of his British patent (Fig. 12 of the United States patent). Beneath the drawing of Fig. 13 is the following statement:

" * * * Diagram of connections for Syntonic Receiver; c being coherer and w a non-inductive conducting or capacity shunt, to eliminate the self-induction of the receiving instrument."

It will be noted that he specifies that the element w is "a non-inductive or capacity shunt" for the purpose of eliminating the self-inductance of the receiving instrument. This is a perfectly clear statement of the purpose of the condenser w which Mr. Loftin has chosen to consider in his sketch "Loftin Sketch L" as a tuning element, and a perfectly clear showing of the fact that Lodge had no intention of using it for tuning.

The statement of the purpose of this element is further supported by the diagram, wherein Lodge illustrates the element w as a resistance. Resistance is an electrical

quantity which makes it entirely suitable for the purpose illustrated in the drawing and described in the explanation underneath it, viz., the purpose of eliminating the self-inductance of the indicating instrument by providing an alternative path.

While resistance is capable of functioning for the purpose described, it is totally incapable of performing a tuning action; that is to say, you cannot tune an electrical circuit by means of resistance.

Since Lodge, in describing this figure of his patent, has clearly stated that the use of the element *w* was for the purpose of providing a shunt, and since in illustrating his descriptive language by means of a drawing of circuits, he has given to this element *w* a form, viz., that of "resistance", which is totally incapable of acting as a tuning agent, there seems to be only one logical conclusion which can be [fol. 1275] arrived at in the matter of Lodge's thought at this time, and that is, that he had no idea whatsoever of tuning the indicating circuit of Figs. 12 or 13 of his patent 609,154.

Q. 211. Referring to Mr. Loftin's testimony, beginning on page 1073 of the Printed Record, will you please discuss the so called "Tesla transmitter and receiver" of the Tesla patents Nos. 645,576 and 649,621 ("Defendant's Exhibits X 2 and L-6" respectively), pointing out what bearing they may have, if any, on the claims at issue of Marconi patent No. 763,772, giving your reasons for any differences of opinion you may have over Mr. Loftin's statements?

A. I have read Mr. Loftin's statements relative to the Tesla patents referred to in your question and I am unable to find in either of them either a disclosure of a wireless system, or of an arrangement capable of functioning in this manner. While Mr. Loftin, in the middle of Printed Record page 1074, states that the fact that Tesla's theory was different from Marconi's is not of consequence, since authorities in this are still groping and guessing as to the real manner of transfer, I am of the opinion that the expression of a theory by an inventor, in this case Tesla, is of the utmost importance in indicating the results sought after and the purpose of the invention.

I also take exception to Mr. Loftin's statement that the art is still "guessing" as to the manner of the transfer,

for I am satisfied that this is an action which takes place through the medium of Hertzian waves. This is the "means" which has been accepted by practically the entire radio art up to the present day and is the means described by all writers on the subject of radio-communication.

Tesla was not unaware of this phenomena; on the contrary, on page 2, lines 73 to 82, he specifically takes note of its existence and specifically disclaims it in the following words:

"It is to be noted that the phenomenon here involved in the transmission of electrical energy is one of true conduction and is not to be confounded with the phenomena of electrical radiation which have heretofore been observed and which from the very nature and mode of propagation would render practically impossible the transmission of any appreciable amount of energy to such distances as are of practical importance."

The significance of this expression, to my mind, is that Tesla, having the conduction theory of operation in mind, and not the radiation theory, proceeds quite naturally to construct apparatus which, as he believes, will work along the lines of his theoretical speculation. *Conduction*, and not *radiation* is Tesla's guide, and he proceeds to follow it, in spite of the absurdities into which it leads him. He knows that gases will conduct when sufficiently rarefied, and he knows that the upper atmosphere is conducting; therefore he proposes to stick up in the air conductors 35,000 or more feet long and the fact that there is no known way of supporting such a conductor, does not worry him in the slightest. Practically, however, it means that the Tesla apparatus never functioned in the manner and for the purpose described by the inventor, and the nearest he comes to a reduction to practice, that is, actual operation, is to connect his arrangements to either end of a vacuum tube some fifty feet long,—interesting as a laboratory experiment,—but without any practical usefulness that I am aware of.

[fol. 1276] Mr. Loftin, of course, contends that the Tesla apparatus, regardless of what Tesla himself was trying to do with it, could be used for purposes of radio-communication, but a little detailed consideration of just what the apparatus is, rather quickly dispels any illusions as to its usefulness for a radio-communication system.

In both patent Nos. 645,576 and 649,621 are shown a transmitter and a receiver for the Tesla system. The figure at the left represents the transmitter and consists of an elevator conducting system D, B, a transformer A, C, of which A is the secondary and C the primary, and an earth connection. The primary C is connected to G, which is a source of electrical oscillations.

In order that a wireless transmitter can function it must have first, a source of electrical oscillations secondly, an antenna system which will permit of the flow of these oscillations and, thirdly, some method of breaking up the electrical oscillations into a code since, without this, the mere radiation of electrical energy into space would accomplish nothing in the matter of transferring intelligence. This latter arrangement is, in the usual wireless system, the operator's key, and while vital to the operation of a radio transmitter, is nowhere disclosed or indicated in either of the two Tesla patents referred to.

The next point to consider in the Tesla patents is the question of whether or not Tesla describes a mechanism of such a nature as to produce high-frequency oscillations and an antenna system of such a nature that these oscillations of the desired frequency can be effectively developed therein.

The patent specifications indicate that the Tesla transmitter has means for generating high-frequency oscillations, which, existing in coil C, act inductively on the secondary A, and produce at the terminals of the coil a very high voltage. This was the primary object of this arrangement of Tesla's, as indicated by lines 85 to 87, page 3, of patent 645,576:

"As the main requirement for carrying out my invention is to produce currents of an excessively high potential",

and in order to accomplish this purpose Tesla gives instructions to make the coil in a particular way, which is contained in the following quotation (lines 58 to 73, inclusive, of page 3):

"The length of the thin-wire coil in each transformer should be approximately one-quarter of the wave length of the electric disturbance in the circuit, this estimate being based on the velocity of propagation of the disturbance through the coil itself and the circuit with which it is

designed to be used. By the way of illustration, if the rate at which the current traverses the circuit, including the coil, be one hundred and eighty-five thousand miles per second then a frequency of nine hundred and twenty-five per second would maintain nine hundred and twenty-five stationary waves in a circuit one hundred and eighty-five thousand miles long and each wave would be two hundred miles in length."

Having constructed the coil in this particular fashion, he next describes the purpose of this construction (lines 78 to 85, inclusive, page 3 of patent 645,576), in the following words:

[fol. 1277] "By such an adjustment or proportioning of the length of wire in the secondary coil or coils the points of highest potential are made to coincide with the elevated terminals D D', and it should be understood that whatever length be given to the wires this condition should be complied with in order to attain the best results."

As will be seen from this description, Tesla proposes to make the secondary of his transformer equal in length to one quarter of the wave length of the oscillations impressed upon it, and to attach to one terminal of the coil an elevated conductor, the coil to be the same, regardless of the length of the antenna. It is at this point that the Tesla transmitter fails completely.

As has been shown by Marconi and confirmed by many years of practical use in order to develop oscillations of a desired frequency in an antenna system, it is necessary that the electrical period of the antenna system, as a whole, should be in tune or have a natural period corresponding to the natural period of the local circuit.

Tesla, however, adjusts the natural period of his secondary coil alone and then directs the attachment to the high potential point of an antenna of any length. When he does this he at once completely upsets the resonant condition of his secondary coil, since the attachment on the antenna adds to the coil a capacity which, in the case of a 35,000-foot wire, would be relatively great and which, even in the case of a wire a few hundred feet long, would be sufficient to absolutely throw the secondary coil out of tune. As a result of this action a high potential would no longer be developed at one terminal of the coil and the resulting flow

of current in the antenna would be negligible, even though very great power were used.

Another way of stating this is to say that Tesla did not choose his secondary coil of such size and his antenna of such size that the product of the inductance and capacity would be the same as in the closed circuit. It seems to me to be rather easy to understand why Tesla missed this all-essential point. He had been using his arrangement with a 50 foot vacuum tube in the laboratory and the attachment of this tube to his secondary coil would produce no disturbance to the electrical conditions therein, since the capacity of the attachment would be negligible. He did not actually test his arrangement with an antenna of the kind described in this patent, because he couldn't build it. Consequently, he has had no practical experience of the sort which would have made evident to him the fact that the attachment of the antenna at once changed the electrical conditions of his secondary.

A transmitter constructed in the manner shown and described by Tesla would, for the reasons just given, be totally worthless as a radio transmitter; or, for that matter, for any other purpose.

In both of the patents under discussion a receiving system is shown, which is totally inoperative for the purposes of a radio receiving system, and which does not involve the mechanism necessary for such a system. In the first place, instead of the sensitive detector and indicating devices which are always necessary in a radio receiver, there are shown some lamps and motors which were expected to receive power through the air from a distant transmitter to operate them. These, of course, are incapable of acting as indicators of the presence of Hertzian [fol. 1278] waves, or of converting Hertzian waves into anything affecting the senses in a manner useful for a communication system.

Tesla again, in the receiver, employs a coil construction of the sort which he employs at the transmitter and which is a quarter wave length long, and to which he attaches the antenna, without regard to the length of the antenna and the effect which its attachment to the coil would have upon its electrical condition.

Actually, however, the attachment to this antenna would entirely change the electrical condition of the coil and would result in an antenna system which, as a whole, would be very

widely out of tune with the incoming oscillations, assuming there were such, and would be entirely useless in a practical radio system.

The receiving arrangement shown in the Tesla patents, for the reasons above outlined, does not disclose the necessary mechanism for a radio receiver and the arrangement is incapable of functioning in any useful manner in a radio system.

Since the Tesla patents fail to disclose either a transmitter or a radio receiver, it follows as a matter of course that they do not disclose a complete radio system.

Mr. Loftin, in attempting to make use of the Tesla patents, as a reference against the Marconi tuning patent, makes certain comments which are easily answered on the basis of the facts just brought out. He quotes as one of the objects of the patent:

"to transmit intelligible messages to great distances." (P. R., p. 1073.)

as indicating that Tesla contemplated a communication system, as well as a system for the transmission of electrical energy.

In view of Tesla's disclaimer of the only possible fundamental basis upon which such a system could operate, viz., Hertzian waves, and his complete failure to disclose an operative arrangement either on his own, or any other basis, it does not appear to me that he is entitled to any credit for having accomplished or taught anything useful as the result of this short quotation.

Mr. Loftin further discusses the question of the height of the antenna systems and introduces the following quotation from Tesla patent 645,576 beginning at the bottom of Printed Record page 1073:

"In some cases when small amounts of energy are required the high elevation of the terminals, and more particularly of the receiving-terminal D', may not be necessary, since, especially when the frequency of the currents is very high, a sufficient amount of energy may be collected at that terminal by electrostatic induction from the upper air strata, which are rendered conducting by the active terminal of the transmitter or through which the currents from the same are conveyed."

This statement is entirely vague and completely fails to indicate what Tesla meant in so far as any definite height of conductor is concerned. Since the whole idea of his arrangement depends upon getting his conductors up into the upper atmosphere, where, due to reduction of pressure, the air is conducting, it is impossible to interpret this quotation to mean, so far as the transmitter at least, is [fol. 1279] concerned, that the elevated wire should be any shorter than is necessary to reach this upper strata.

I might also point out that even if the elevator conductors were very much shorter than required by this condition, their attachment to the coils of the Tesla arrangement would result in an antenna system hopelessly out of tune.

Mr. Loftin further quotes, page 4, commencing line 27 of patent to Tesla, 645,576 (P. R., p. 1075):

"The primary and secondary circuits in the transmitting apparatus being carefully synchronized, an electromotive force from two to four million volts and more was obtainable at the terminals of the secondary coil A."

and states that this is an instruction to tune the primary and secondary circuits together. He omits to point out, however, that this quotation is part of Tesla's description of the only actual use he ever made of his arrangement, viz., to connect it up to a 50-foot vacuum tube and that there is, therefore, no antenna attached to it.

When Tesla did connect an antenna to it, not actually, of course, but in the drawings of his patents, he did not know or appreciate the fact that the resulting arrangement would be completely de-tuned.

* * * * *

In connection with my statements above relative to the action of a Tesla coil when attached to an antenna, I am reminded of some actual tests illustrative of what I have just said, which I witnessed some years ago.

During the course of the trial of the suit against the Kilbourne & Clark Manufacturing Company at Seattle, Washington, Mr. G. W. Pickard, defendant's Expert in that case, conducted a demonstration of what purported to be an arrangement of the Tesla patent 645,576, in so far as the transformer A, C of this patent was concerned. The secondary coil was supposed to be constructed in accordance with the directions on page 4, lines 3 to 7 of said patent, and to have a total length of wire of some 300 meters, the length

of wire being determined by Tesla's instruction found on page 3, lines 58 to 64 of said patent:

"The length of the thin-wire coil in each transformer should be approximately one-quarter of the wave length of the electric disturbance in the circuit, this estimate being based on the velocity of propagation of the disturbance through the coil itself and the circuit with which it is designed to be used."

the disturbance in the closed circuit in this case being 1200 meters.

[fol. 1280] As demonstrated, while the coil had fifty turns, the total length of wire was only 200 meters, so that the coil was short 100 meters of the amount specified by Tesla.

When demonstrated by Mr. Pickard, only five and a quarter turns of this coil were actually employed, the other forty-four and three-quarters not being used at all. The antenna employed was a small antenna of about the dimensions of a ship's antenna.

Tesla's instructions contained in the patent, and already quoted, are very specific to the effect that the elevated conductor should be connected to one terminal of the coil and the earth to the other terminal; an instruction which, if carried out in actual practice, results in a completely inoperative system.

The fact that in the tests just referred to only five and one-quarter turns could be employed, while the remaining turns were left idle, shows how very far out of tune any aerial system would be if constructed in accordance with Tesla's instructions.

In the ordinary operation of a radio transmitter one or two turns of the inductance coil, usually employed, is sufficient to seriously detune the aerial system. Consequently since in the case of the test referred to the aerial system was in tune when five and one-quarter turns were included in the circuit, it follows that if the entire secondary coil had been included, the antenna system would have been so far out of tune as to be utterly useless.

Mr. Loftin's statement on Printed Record page 1076:

"Adjusting the length of wire to one-quarter of a wave length, as set forth in the first part of the quotation, is a very common rough or thumb rule used among practical radio workers for obtaining approximate resonance in wire conductors. When the result mentioned in the last part of

the quotation is obtained; that is, when the highest potential exists at the elevated terminal resonance is actually obtained, and Tesla points out that this is the final test irrespective of the thumb rule as to length of wire, and points out that 'best results' are obtained when this adjustment is attained; that is, that there is resonance between the elevated conductor circuit and the primary oscillating circuit feeding energy into the elevated conductor circuit."

is correct in so far as resonance between the primary circuit and the secondary coil is concerned; that is to say, Tesla directed the construction of a coil whose own natural period corresponded to that of the closed circuit. This is a possible construction due to the fact that a coil of wire has not only inductance, but a capacity; consequently it can have a particular natural period.

Mr. Loftin's statement in the concluding part of the quotation, that there is resonance between the closed circuit and the open *circuit* is entirely incorrect for reasons which have been discussed at length in this answer.

It may be of interest in connection with Tesla's work, to point out certain facts in his experience and their bearing on his attempt to construct a system for the transmission of electrical energy through the upper atmosphere. Tesla was primarily a power engineer and his work in the development of the polyphase electric motor was of very [fol. 1281] great importance, but in the carrying out of this type of work his mind naturally fell into a particular channel, dominated by this experience.

When he undertook the work in connection with high-frequency oscillations it is evident that he was inspired by the idea of carrying power to a distance without wires, but this inspiration led him into a field in which he was no longer master of the technique involved. This sort of thing is a matter of common observation to engineers of long experience, and it is a well-known fact that no matter how thoroughly trained and experienced an engineer may be in some particular field, when he steps into a new field it requires a long period of time to become familiar with the technique involved.

It has been my custom in the past, when employing radio engineers who were experienced in other branches of electrical work, to expect that a period of at least five years

in radio work would be required before they would be really good radio engineers.

Tesla's work, which was of real consequence, is referred to and described in the Martin book, of which "Defendant's Exhibit B-4" is an extract. The first half of this book is devoted to this phase of Tesla's accomplishments in poly-phase power apparatus. The second half describes a little of his work when he took up high-frequency phenomena, and which, while it evidently inspired Tesla to dream great things, never led to anything of real usefulness, but merely to some arrangements capable of producing interesting and spectacular effects in the laboratory, and in the diagrams shown in the Martin book, the dominance of the power-transmission idea is evident.

Q. 212. Will you please consider the British patents to Braun Nos. 1,862 of 1899, and 12,240 of 1899 ("Defendant's Exhibits Nos. Z-2 and A-3"), as referred to by Mr. Loftin on page 1076 of the Printed Record and state what bearing, if any, they have upon claims in issue of Marconi patent No. 763,772?

A. I note that Mr. Loftin, page 1076, has made a brief reference to these two patents and states that patent No. 1,862 discloses a transmitting arrangement, while patent No. 12,420 discloses a receiving circuit. Transmitter patent No. 1,862, while it discloses a circuit containing a condenser coupled to a second circuit, makes no suggestion of tuning.

Examination of the patent discloses that Braun had a very hazy idea of what he was trying to do and his principal interest seemed to lie in getting a somewhat longer wave length than had previously been used.

In my opinion, the disclosures of this patent 1,862 to Braun have no particular bearing on the Marconi tuning patent 763,772.

Braun's receiver patent No. 12,420 deals with a receiving arrangement which is little more than a technical curiosity, and I am unable to discover therein any disclosure of significance, or any disclosure having a bearing on the Marconi four-circuit tuning patent.

Mr. Loftin's statement, Printed Record, page 1076, to the effect that these two patents disclosed a four-circuit system, does not involve any contention that they are tuned, nor any contention that either patent shows a combination employing both transmitter and receiver.

It is my opinion, therefore, that the Braun patents fail to disclose anything relative to the invention of the Marconi patent 763,772.

[fol. 1282] Mr. Vaill: Counsel for claimant offers in evidence a photostat copy of page 52 of the Lodge book entitled "Signalling Through Space Without Wires" (3rd Edition), and requests that the same be marked "Claimant's Exhibit No. 249".

(Said exhibit marked as requested.)

Q. 213. Please consider Mr. Loftin's statements concerning what is disclosed in the letters passing between Mr. Joseph D. Baker and Mr. John S. Stone, purporting to be dated June 30, 1899, July 18, 1899, and July 22, 1899 ("Defendant's Exhibit F-3"); also Mr. Stone's original application for his patent No. 714,756 ("Defendant's Exhibit R-3") and also the so-called Stone transmitter and receiver, purporting to be illustrated in the Pickard chart ("Defendant's Exhibit O-5"), and referred to in his testimony, as stipulated on pages 1197-1198 of the Printed Record, and state whether you agree with Mr. Loftin's opinion that said letters or the original Stone application, or his patent as issued, disclose the Marconi transmitting and receiving apparatus of patent No. 763,772 in suit, giving your reasons for any opinion you may express.

A. While Mr. Loftin's statements relative to the Stone-Baker letters and the Stone patent No. 714,756 are very lengthy, the facts disclosed in these documents are simple, readily understood and are quite different from Mr. Loftin's exposition. Stone does not disclose four-circuit tuning and, furthermore, it is perfectly obvious from both the letters and the patent, that he did not want to tune his antenna circuit but, on the contrary, proposed to generate oscillations in a closed circuit of whatever frequency he wished and to force these oscillations upon his antenna at the transmitting end, and to extract them from the atmosphere at the receiving end by means of an antenna system which was not tuned, but which had associated with it a closed circuit which was tuned.

The words "forced oscillations" or "forced vibrations" used continually by Stone throughout the letters and his patent, have but one significance in this art, viz., vibrations or oscillations differing in frequency from that of the circuit

on which they are impressed. Stone was a man possessed of unusual theoretical knowledge relative to the behavior of circuits, understanding fully the means necessary to tune an electrical circuit and capable of employing language exactly descriptive of his purpose and of drawing circuits illustrative of his purpose when he desired to tune a circuit. Nowhere in the Stone-Baker letters, or in the subsequent patent, in which he reduced his ideas to practice, is there a disclosure of a variable inductance or other variable tuning element in the antenna circuit.

While Stone illustrates in detail the principles of operation and the necessary apparatus for the tuning of the circuits associated with his antenna system, he neither shows in the sketches, nor describes in words, any method of tuning the antenna system.

In the light of Stone's mastery of electrical technique, it is inconceivable that this omission is the result of anything other than the fact, very completely brought out in both the letters and the patent, that he did not want the antenna to be tuned; but, on the contrary, expressly desired that the antenna period should not correspond to the period of the oscillations forced upon it. His whole theory of [fol. 1283] operation requires such a condition and is expressed at one point in the Stone-Baker letters as follows:

“* * * In my arrangement the vibratory current developed in the vertical wire is not due to the oscillatory discharge of the wire but is due to a simple harmonic electromotive force impressed upon it which electromotive force *produces* forced current vibrations in the wire which forced vibrations as is well known depend for their period and form only upon the period and form of the impressed forces and not upon the electromagnetic constants of the circuits in which they are developed as in the case with *free or natural* vibrations of a system.”

This quotation expresses in technical language the fact that the electrical oscillations impressed upon the antenna system were to be of a nature quite independent of the effect of the electrical constants of the antenna circuit, a condition which is directly contrary to tuning; that Stone in his use of the words “forced oscillations” intended to sharply differentiate this method of operation from that

of the Marconi circuits is evident from his own statements contained in his patent No. 767,975, page 2, lines 70 to 113:

"A sharp line³ of demarcation is to be drawn between the system herein described and such systems as that described, for example, in British Patent No. 7,777, series of 1900. In the system herein described the frequency of the radiated waves is determined solely by the capacity and inductance of the sonorous circuit, which, determining the frequency of the electrical oscillations developed in said circuit and by it forced in the elevated conductor, necessarily determine the frequency of the waves radiated by said elevated conductor, the length or other geometric constants of said elevated conductor or its fundamental or its natural periods having no effect in determining the frequency of the radiated waves. In the system described in said British patent and elsewhere, as, for example, in the *Journal of the Society of Arts*, Vol. LI, page 722, in connection with Fig. 14, the frequency of the radiated electromagnetic waves is determined not solely by the capacity and inductance of the sonorous circuit associated with the elevated conductor independently of the capacity and inductance of the latter, but by the capacity and inductance of the elevated conductor taken in conjunction with the capacity and inductance of the associated sonorous circuit and the mutual inductance and capacity of the two circuits. In these systems, which are systems of at least two degrees of freedom, as explained in my prior Letters Patent, any change in the length or other geometric constants of the elevated conductor whereby the capacity and inductance of said conductor is altered will produce a change in the frequency of the radiated waves, and therefore it cannot be said that electrical oscillations in the elevated conductor are forced oscillations of a frequency determined by the electromagnetic constants of the sonorous circuit and irrespective of the constants of the elevated conductor."

The above quotation so completely and unmistakably expresses Stone's thought in the matter of the difference [fol. 1284] between a system employing forced oscillations such as that described in the patent from which the quotation was taken and the Marconi system disclosed in Marconi British patent No. 7,777 ("Plaintiff's Exhibit No. 34"), that is, the tuned system, that further comment on this point

would be superfluous, and I will merely add in explanation that the Stone patent No. 767,975 discloses a system employing forced oscillations, in which respect it is identical with those disclosed in the Stone-Baker letters, and the Stone patent under discussion, No. 714,756.

In the Stone-Baker letters are statements used and misinterpreted by Mr. Loftin, as follows (P. R., p. 1077):

"Instead of utilizing the vertical wire itself at the transmitting station as the oscillator, I propose to impress upon the vertical wire, oscillations from an oscillator, which oscillations shall be of a frequency corresponding to the fundamental of the wire. Similarly at the receiving station, I shall draw from the vertical wire, only that component of the complex wave which is of lowest frequency."

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"If now the fundamental of the wire at the receiving station be the same as that of wire at the transmitting station, then the receiving station may receive signals from the transmitting station, but if it be different from that of the transmitting station, it may not receive those signals."

These quotations are the only statements found in the Stone-Baker letters which make any reference to a definite natural period for the antenna system, and require a brief consideration.

In the first place this is not a statement to the effect that the *antenna circuit* shall be tuned, but simply that the natural period of the wire taken alone shall correspond to that of the closed circuit and, as is shown from Stone's sketches, he proposes to insert a coil between the base of this antenna and the earth, in order to drive it—a method of procedure entirely in accordance with the idea of forced oscillations.

It is of interest at this point to note that whereas Tesla suggested tuning the coil itself and then attaching an antenna, overlooking entirely the fact that his *antenna circuit* would then be completely detuned, Stone goes on the other side of the fence as it were, and suggests an antenna which, when taken by itself, might be tuned, and then inserts an inductance between the base of the antenna and earth, which results in a complete detuning of the antenna circuit. Stone was on one side of the correct principle, Tesla on the other side, while Marconi stood in between with a

recognition of the true principle, viz., that the *antenna circuit* should be tuned.

There is an interesting exposition of Stone's valuation of this suggestion contained in the quotation from the Stone-Baker letters to be found in his patent No. 714,756, page 2, lines 15 to 35, which are as follows:

"* * * Thus the frequency impressed upon the elevated conductor may or may not be the same as the natural period or fundamental of such conductor; but, as will be hereinafter explained, an elevated conductor that is aperiodic may be employed and is best adapted for use when the apparatus is to be used successively for different frequencies, and such aperiodic elevated conductor is likewise the preferred form of elevated conductor when two or more frequencies are to be simultaneously impressed upon or received by a single elevated conductor; but forced simple harmonic electric vibrations of different periodicities may each be separately impressed upon a different elevated conductor, and the several energies of the resulting electromagnetic waves may be selectively conveyed each to a separate translating device."

The statements above contain one of the instructions in the Stone patent to tune the antenna wire, as distinguished from the antenna circuit and were inserted in the patent April 11, 1902, which date is subsequent to the disclosure by Marconi in his British patent No. 7,777 of 1900.

It is quite apparent from this fact that Stone did not consider the reference in his letters to Baker relative to tuning the antenna wire to be of any particular consequence when he applied for his patent February 8, 1900, and his insertion of this statement some two years later and subsequent to Marconi's disclosure, speaks for itself.

Stone's main thought in the employment of forced oscillations was first of all to secure a system which would produce a relatively pure wave and, secondly, as is indicated in his patent, to enable one antenna system to transmit and receive two or more messages simultaneously, which particular branch of his thought was along the same direction as some of his previous work in wire line transmission as, for example, that shown and described in his patent No. 638,152 ("Defendant's Exhibit U-3").

Stone's principle of forced oscillations, while interesting as a theoretical speculation, never resulted in a practical accomplishment, or, rather, in any practical system of radio-communication, due to the fact that tuning of the antenna circuit is an inescapable requirement, and any attempt to work without it, results in such an enormous waste of power that for practical purposes it is useless.

Mr. Loftin shows in his sketch "Loftin Sketch M" at the top of page 1078 of the Printed Record, an arrangement of transmitting and receiving circuits which purports to be the Stone disclosure, but is actually made up, as admitted by Mr. Loftin, of arrangements found partly in his patent and partly in the Stone-Baker letters.

It will be noted that the inductance coil in the antenna is not variable, but is fixed, which, in the light of the facts already brought out in my answer is, by itself, quite sufficient to show that Stone did not intend to tune his antenna system.

Mr. Loftin quotes, Record Page 1079, the last paragraph of the Stone Baker letter of June 30, 1899, as follows:

"The tuning of these circuits one to another and all to the same frequency will probably be best accomplished empirically, though the best general proportions may be determined mathematically."

and states that this quotation leaves no doubt that Stone intended to tune all four circuits. As a matter of fact, the only statement in either the letters or the patent which give any clue to what Stone meant by this quotation is the statement already quoted relative to tuning the antenna wire—not the antenna circuit, and which instruction was [fol. 1286] not inserted into the Stone patent until Marconi had disclosed tuning in his British patent.

Mr. Loftin further states in commenting on this quotation, that Stone clearly shows inductance coils and condensers in all of his circuits and that from the teachings of Lodge, he knew how to use a variable inductance to tune the antenna circuit.

As I have already pointed out, Mr. Stone was possessed of most unusual technical knowledge in the matter of electrical circuits and his omission of the variable tuning element in the antenna circuit was not the result of ignorance

relative to the action of such an inductance in an electrical circuit, but the result of his definitely indicated purpose of having an antenna circuit which was not tuned.

Mr. Loftin's interpretation of the following quotation from the Stone-Baker letter of July 18, 1899, found on Printed Record, page 1079, viz.:

"In my arrangement the vibratory current developed in the vertical wire is not due to the oscillatory discharge of the wire, but is due to a simple harmonic electromotive force impressed upon it which electromotive force produces forced current vibrations in the wire which forced vibrations as is well known depend for their period and form only upon the period and form of the impressed forces, and not upon the electromagnetic constants of the circuit in which they are developed as is the case with free or natural vibrations of a system."

is a use and interpretation of the expression "forced oscillations," which is quite contrary to the usage of the radio art, and it is not customary to speak of a circuit which is in tune as being "forced" to accept oscillations of its own period.

Mr. Loftin emphasizes, at the bottom of Printed Record, page 1080, and the top of page 1081, Stone's direction relative to the use of "swamping" inductance and the looseness of coupling which would result therefrom. While it is a fact that the inductance referred to by Mr. Loftin would result in loosening the coupling, it is also a fact that in order to make the Stone system operate at all with its forced oscillations and an aerial system greatly out of tune, it would be necessary to use a very close coupling.

Mr. Loftin next takes up the discussion of the Stone patent and attempts to make Stone tune the antenna circuit by referring to a statement in the Stone-Baker letters relative to empirical tuning. Stone was far too good a technician to have allowed his patent to issue without clearly indicating how to tune his antenna circuit, had this been his purpose. Not only was he familiar with electrical theory, but, in the closed circuits described in this patent, he gives definite instruction, and discloses the necessary means for carrying out his purpose, and I shall consider that this comment applies to all statements made by Mr. Loftin, to the effect that tuning in the antenna circuits of the Stone patent can be "inferred."

On Printed Record, page 1084, Mr. Loftin refers to Figures 5 and 6 of the Stone patent No. 714,756 and states that they are the same as Figs. 1 and 2 of the Marconi patent 763,772, and that they disclose a radio system in which the transmitter and receiver each embody two circuits tuned alike, and all four circuits tuned together. This statement, of [fol. 1287] course, rests entirely on the "inferred" tuning of the antenna circuits and, in fact, resemblance to the Marconi patent lies largely in the fact that the drawings look somewhat alike.

In so far as the disclosure of useful and valuable information is concerned, the two patents are totally unlike; that of Marconi being one of the outstanding contributions to the radio art, while that of Stone being an arrangement which, for all practical purposes is inoperative.

Marconi discloses a system in which all four circuits are tuned together, while Stone discloses a system primarily for the purpose of multiplex wireless telegraphy and involving antenna systems which are forced to oscillate in a manner determined by an electromotive force impressed upon them, and not in a manner determined by the electrical constants. Marconi drives his antenna circuits in the way in which they want to go, while Stone tries to make them go in some different manner, and the results obtained in the two cases are very similar to those obtained when these two methods of procedure are applied to human beings.

Mr. Loftin, on Printed Record, page 1085, comments on the fact that Mr. Stone understood how to so connect his detector in the oscillating circuit of a receiver that the resistance of the detector should not be included in the tuned circuits, a teaching which Mr. Loftin seems to have forgotten when he attempted to make the secondary circuit of Marconi patent 627,650 a tuned circuit.

On Printed Record, page 1085, Mr. Loftin sums up the matter of "novelty" or otherwise in the Marconi patent, and states:

"There certainly can be no novelty in the Marconi patent in the matter of tuning, resonance, or syntony, because there was no lack of information in the art on this subject."

While I am aware of the fact that prior knowledge in an art has a certain bearing on the technical question of invention as disclosed in the patent, yet I have, as the result of

many years of experience with inventions, something in the nature of a contempt for statements of this sort when the invention is one of such outstanding importance as that of the Marconi patent 763,772 and when I consider the tremendous gap which exists between the existence of information and the employment by someone of that information for a useful purpose.

Were it only necessary, in order to produce an invention, to have available the information on which that invention is based, then most of the inventions which will be made in the next ten years or more would be made today.

In the case of the Marconi patent, of course, this condition in fact does not exist, since, while the scientific principles of resonance, etc., were understood, their application to a radio system prior to Marconi's patent, was not, and the fact that such skilled workers as Tesla and Stone completely missed, one on one side of the fence, as it were, and the other on the other side, illustrates far more convincingly than anything which I can say, the magnitude of Marconi's accomplishment in his correct solution of the problem.

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[fol. 1288] Mr. John Stone Stone, in testifying in the suit of Marconi Wireless Telegraph Company of America *vs.* Kilbourne & Clark Manufacturing Company, which testimony has been stipulated into the present case, a part of which is found on pages 924 and 925 of the Printed Record in this case, makes statements which are of considerable interest relative to both the original Marconi patent No. 11,913 and the four-circuits tuning Marconi patent No. 763,772. This testimony is as follows:

"194. Cross-question. Did you testify for the defendant in a suit of the National Electric Signaling Co. against the Telefunken Co. on a patent to Fessenden, No. 928,371, in September, 1911, as follows:

"Will you please give a concise statement of the principles involved in radiotelegraphy, as a practically applied art, including in your statement its genesis and evolution down to and including the date of Marconi's British patent No. 7,777 of April 26, 1900, as respects its development after that date. I will ask you subsequently concerning each step thereafter.

'A. Referring first to the work of Marconi, it is safe to say that his British patent No. 12,309 of June 2, 1906, was the first patent ever granted for an operative system of radiotelegraphy based upon a creation and detection of radiated 'Hertzian or electromagnetic waves.' "

"Answer. I believe I made that statement.

"195. Cross-question. Did you also testify in that same case as follows:

'Q. 28. Now, please state briefly the character of the apparatus constituting the next decided step in the art made by Marconi.

'A. The British patent No. 7,777 of 1900 discloses the really important advances made in the art at that date. Marconi therein discloses a variable inductance coil in series in the antennae, or aerial structure, conductor, and the tuning condenser in shunt with the primary of the transformer in a tuned secondary of which is connected the detector and tuning condensers and inductance coils. Both the condenser in the primary and secondary and tuning inductance coils in the secondary, are made variable for the purpose of tuning the circuits with which they are associated.'

"Answer. I believe I made that statement.

"196. Cross-question. And in the same case did you not also testify as follows:

'Q. 10. Speaking generally, how do the subsequent advances in the art of radiotelegraphy, down to the present [fol. 1289] time, compare in relative importance to what was summed up in Marconi's two British patents of 1906 and 1900, to which you have referred, and others substantially co-contemporaneous with the latter?

'A. Though it is undoubtedly true that the apparatus substantially as it is clearly shewn in the separate drawings of Marconi's British patent, is preserved in every efficient form of commercial apparatus, and of all systems used today, it is equally true that many of the elements in it were not of his invention.'

"Answer. I believe I made that statement.

"197. Cross-question. And did you not also testify in that same case as follows:

'The first very clear and complete exhibition of the use of a continuously variable tuning condenser in shunt to the

primary of a transformer in a wireless telegraph receiver, so far as I am aware, is contained in the specifications and drawings of the English patent to Marconi, No. 7,777, of 1900.'

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"Answer. I believe that is a correct statement of what I said."

The British Patent No. 7,777, referred to in Mr. Stone's testimony, corresponds to the United States Patent No. 763,772, and Mr. Stone's statements, quoted above, unmistakably bring out the fact that Stone himself credits Marconi with being the first to use the tuning elements in the aerial circuit in conjunction with tuned and coupled local circuits, and seems to me to be conclusive to the effect that he himself had not used or described such an arrangement. This statement by Mr. Stone is quite in accord with my own remarks relative to the Stone-Baker letters and the Stone patent No. 714,756.

Mr. Stone's statements relative to the apparatus of Marconi's patent being substantially preserved in every efficient form of modern radio apparatus, is also in accord with the statements which I have made on the same subject.

The reference to Marconi's British Patent No. 12,309 of June 2, 1906, is evidently a misprint, so far as the patent number and date are concerned. Examination of the original Kilbourne and Clark record shows the same misprint, but the patent introduced as "Defendant's Exhibit No. 33. 1-8" in that case is the Marconi patent No. 12,039 of June 2, 1896, which is the correct number and date for the original Marconi patent.

It is of interest to note that Mr. Stone refers to this patent as the first ever granted for an operative system of radio telegraphy.

I note a reference on page 6 of Stone Patent No. 714,756 to the construction of a vertical wire highly resonant to a particular frequency (lines 62 to 70), as follows:

"The vertical wire may with advantage be so constructed as to be highly resonant to a particular frequency, and the harmonic vibrations impressed thereon may with advantage be of that frequency. The construction of such a vertical wire is shown and described in other applications of mine now pending."

which statement was inserted into the patent application April 11, 1902, more than two years after the date of filing of the application, and much later than the date of publication of the British Marconi Patent No. 7,777.

Again, on page 9, line 130, to line 5, page 10 of Stone patent No. 714,756, is the following statement:

"* * * Both of the circuits I have spoken of are tuned circuits, and they may be conveniently distinguished with reference to their respective functions by denominating the circuit employed in the development of the vibrations as an 'Oscillating' or 'sonorous' circuit and by denominating the circuit employed in the reception or absorption of the vibrations as a 'resonant' circuit."

This statement seems to be intended to indicate some sort of tuning of the aerial system, a statement quite unsupported by the drawings of the patent, and it was inserted into the application June 19, 1902, which was after the publication of the British Marconi Patent No. 7,777.

These references are cited as showing that everything in the Stone patent 714,756 which might be interpreted to mean tuning of the antenna circuits was put into the patent after Marconi's work was known, and the importance of having all four circuits in tune, appreciated.

The original disclosures of the Stone patent 714,756 in the matter of the drawings did not disclose any means for tuning the antenna circuits, and these insertions at a much later date indicate the attempt by Stone to get into his patent as much as possible of Marconi's work.

Mr. Vaill: Counsel for claimant offers in evidence printed copy of patent No. 767,975 to J. S. Stone, dated August 16, 1904, referred to by the witness in his last answer, and requests that the same be marked "Claimant's Exhibit No. 250".

(Said exhibit marked as requested.)

Q. 214. Will you please refer to Mr. Loftin's answer to Q. 27 of his deposition, where he considers the claims of the patent in suit No. 763,772, in view of the prior art, on pages 1087 to 1091, inclusive, of the Printed Record, and state wherein, in view of your knowledge and experience, you may agree or disagree with Mr. Loftin's statements regarding said claims?

A. Referring now to claim 1, Mr. Loftin undertakes to read this on the prior art, bringing in Stone and Tesla. A necessary element in this claim is the variable inductance included in the open circuit, which is not disclosed in either Stone or Tesla.

The signaling instrument called for by this claim requires an operator's key of some sort, and no such device is to be found in Tesla.

Claim 3: This claim again requires a variable inductance and a signaling device. Neither Tesla nor Stone, cited by [fol. 1291] Mr. Loftin against claim 3, show a variable inductance, and Tesla does not indicate any transmitting key.

This claim covers means for adjusting the oscillation period of each of the two circuits, to bring them into accord with each other.

Mr. Loftin again cites Tesla and Stone in connection with this claim, but neither discloses the means necessary for tuning the two circuits.

Claim 8 is similar to claim 6, except that it refers to a variable inductance in the open circuit.

Loftin again cites Tesla and Stone, stating that Tesla has provided means for varying the number of turns. The patent does not disclose anything whatsoever which can be interpreted to mean varying the number of turns in a manner necessary to ~~tune~~ tune the antenna. As I have previously pointed out, he has merely directed the tuning of the oscillation transformer secondary alone and attaches his aerial thereto, regardless of the resulting consequences, which are fatal to the requirements of successful operation.

The reference to Stone in the matter of tuning the aerial wire "empirically", does not in any way meet the requirements of this claim, which requires a variable inductance, said variable inductance not being shown in Stone and all of the descriptive language in the patent which might be interpreted to indicate tuning having been inserted after the publication of the British Marconi Patent No. 7,777.

Claim 11: This is the same as claim 1, except that a signaling device; that is, the operator's key, is separately specified as one of the elements of the claim. Mr. Loftin refers to the switch S in his "Tesla Sketch A" as being something which one skilled in the art would naturally connect to the Tesla arrangement, but it was not connected there by Tesla himself and, therefore, I see no anticipa-

tion or meeting of the requirements of this claim by Tesla. Stone, however, does disclose the operator's key.

Mr. Loftin comments (No. 3, claim 11) on that part of the claim which reads as follows:

"* * * the secondary coil of the oscillation-transformer electrically connected, at one end to capacity and, at the other end, to an inductance, and an aerial conductor connected to the inductance, substantially as and for the purpose described."

Referring to Fig. 1 of patent 763,772, the oscillation-transformer referred to is indicated by d' , the capacity by the earth E and the inductance by the coil g .

Neither Stone nor Tesla disclose an inductance coil similar to g' , but only one coil, corresponding to the oscillation-transformer coil d' , and Mr. Loftin's very curious statement under heading (3), is to the effect that the secondary of the oscillation-transformer is connected to itself, and since it is an inductance it is therefore connected to an inductance in the circuit.

As an illustration of the way in which the English language can be employed to convey incorrect impressions, the statement is very good, but it is quite evident from the drawing of Fig. 1 of the Marconi patent 763,772, that Mar-[fol. 1292]coni was talking about and claiming a coil additional to the secondary of the oscillation-transformer.

Claim 12: An extension of claim 11, requiring that the additional inductance be variable, Loftin again cites Tesla and Stone but, as already pointed out, neither discloses a variable inductance in the open circuit.

All of the claims so far covered refer to the transmitting station.

Loftin next takes up the receiving claims.

Claim 2: This claim requires the combination of a variable inductance in the antenna circuit and a wave-responsive device electrically connected with said inductance and in circuit with a condenser.

Mr. Loftin cites Lodge, Marconi's 1899 patent and Stone, as meeting the requirement. The wave-responsive device referred to by this claim, is shown as T in Fig. 2 of the patent and, as shown in Fig. 2, this device, which is a coherer, is in circuit with condenser j^3 and also with condenser h' . Condenser h' being for the purpose of tuning the secondary circuit. While the Lodge patent discloses

the use of a variable inductance in the antenna circuit, it does not disclose a tuned secondary circuit, nor the use of a detector connected in shunt with a condenser similar to the connection shown between T and h' in Fig. 2 of the patent to Marconi.

The Marconi 1899 patent does not show a variable inductance in the primary circuit, consequently does not meet the requirement of this claim. While Stone discloses a wave responsive device in circuit with a condenser, it does not disclose a variable inductance in the primary circuit; consequently it fails to meet the combination required by the claim.

Claim 13: Loftin again cites Lodge, Stone and the Marconi 1899 patent. This claim requires a variable inductance in the antenna circuit, as shown by g' of Marconi patent 763,772 and a wave-responsive device connected with the secondary winding of the oscillation transformer.

Neither Lodge, Marconi nor Stone show a variable inductance in the antenna in addition to the secondary of the oscillation-transformer, and none of them disclose this combination.

I therefore find that none of the prior art cited against this claim by Mr. Loftin discloses the combination of elements called for therein.

Claim 14: This claim requires means in both the open and closed circuits for adjusting the time-periods of the open circuit and the closed circuit into electrical resonance with each other. Loftin cites Lodge and Marconi 1899 patents and contends that, in the case of the Lodge patent, one adjustment only is sufficient to bring the circuits into resonance. This, of course, cannot be the case, since the antenna circuit must be adjusted to correspond either with the frequency of the incoming signal, or the product of the inductance and capacity of the transmitter circuit, while the secondary circuit must then be capable of adjustment in a corresponding manner. Lodge discloses no means of tuning the secondary circuit, nor does he recognize anywhere in his patent, the advantage of so doing.

[fol. 1293] Mr. Loftin's statements relative to the 1899 patent have already been referred to in a previous answer, and are to the effect that Marconi provided for varying the number of turns of j' of the 1899 patent and the capacity of condenser K.

As stated in my previous remarks, condenser K is incapable of tuning the secondary circuit; consequently, there is no disclosure in this patent of two-circuit tuning.

It is evident, therefore, from the above remarks, that none of the disclosures of the prior art referred to by Mr. Loftin, provide the combination called for by claim 14.

I omitted to mention that Loftin also referred to Stone, but, as stated so many times already, Stone did not disclose any mean for tuning the antenna circuit and, therefore, no means for bringing the two circuits into tune with each other.

Claim 16: Mr. Loftin's only comment on this claim is that it is the same as claim 14, except that it claims the condenser *h* of Fig. 2, Marconi patent No. 763,772, which Mr. Loftin states:

"* * * is merely one of the 'empirical' methods employed by the art."

Perhaps the best answer to this comment is Mr. Stone's statement contained in the testimony which I quoted from my last answer, as follows:

"197. Cross-question. And did you not also testify in that same case as follows:

"The first very clear and complete exhibition of the use of a continuously variable tuning condenser in shunt to the primary of a transformer in a wireless telegraph receiver, so far as I am aware, is contained in the specifications and drawings of the English patent to Marconi, No. 7,777, of 1900."

"Answer: I believe that is a correct statement of what I said."

Mr. Stone's statement and Mr. Loftin's failure to cite any prior art complying with the requirements of this claim, indicate that it was a new and novel combination.

Claim 17: Requires means included in each of the circuits for adjusting the circuits in resonance with each other. In Fig. 2 of the Marconi patent 763,772 the open circuit is provided with two means, viz, coil *g'* and condenser *h*, while the secondary circuit is provided with variable coils *g''* and a variable condenser *h'*.

Mr. Loftin, commenting on this claim, attempts to read Lodge into it, stating that varying condenser *w*, shown in

the "Loftin Sketch L," is for the purpose and capable of tuning the secondary circuit.

As I have already pointed out in connection with this condenser w , Lodge specifies a resistance as an alternative to the condenser, which specification precludes the possibility that Lodge was thinking of tuning, since resistance can never be used to tune the circuit, a fact well known to Lodge, or anyone else familiar with electrical circuits. Furthermore, in the position shown in Mr. Loftin's Sketch L, the condenser w is incapable of tuning, because the high [fol. 1294] resistance of the detector intervenes between the condenser and the inductance and is therefore in circuit with them and its high resistance prevents tuning.

The Marconi 1899 patent is cited by Mr. Loftin, but has been disposed of in previous answers.

I find no disclosure of the combination called for by claim 17 in the prior art.

Claim 18: This claim is the same as claim 17, except that it calls for the specific means,—viz., a variable inductance included in both circuits—for the purpose of tuning.

Loftin attempts to find these elements in Lodge and Stone, but while Stone shows a means for tuning the closed circuit, and Lodge the means for tuning the open circuit, there is no disclosure in the patents or publications of either of the combination.

Claim 19: This is similar to claim 18, with the addition of a receiving instrument and battery. Loftin again cites Lodge, Stone and Marconi 1899 patents, but, as already pointed out, none of these disclose a variable inductance in both circuits.

The next claims dealt with cover both stations.

Claim 10: This claim requires an open circuit at the transmitter and receiver, and a closed circuit at each station, and all four circuits in resonance with each other. A transmitter and a receiver complying with this requirement are shown in Figs. 1 and 2 of the Marconi patent 763,772, and the specification, page 2, lines 117 to 129:

Loftin cites Tesla, Marconi 1899 patent, but these references have, I think, been completely disposed of in my previous answers. He also refers to his "Stone Sketch M" and the statement in the Stone letter June 30, 1899, as follows:

"The tuning of these circuits one to another and all to the same frequency will probably be best accomplished empirically, though the best general proportions may be determined mathematically."

as a disclosure of four-circuit tuning.

I have already pointed out that Stone was working on a totally different idea, disclosed nowhere either in his letters or patent the necessary means for securing four-circuit tuning and, in fact, in the patent itself, did not put any statements of the sort contained in this quotation until after Marconi's disclosure when, having learned the importance of the four-circuit tuning, he attempted to get some of it into his own patent. An attempt, however, which is unsupported by either the original disclosure in the specification or the drawings.

I do not find, therefore, that claim 10 of Marconi patent 763,772 is found in any of the prior art cited by Mr. Loftin.

Claim 20; Mr. Loftin's comment on this is to the effect that it is met by his references cited against claim 10, with which I disagree, for the reasons outlined in my remarks on claim 10.

Q. 215. In answer to Q. 28 of Mr. Loftin's deposition he reviews the File Wrapper and Contents of Marconi patent No. 763,772, and attempts to point out the significance of [fol. 1295] the citations by the Examiner of the Patent Office of certain patents in the prior art, particularly Tesla patent No. 645,576, Lodge patent No. 609,154 and Stone patent No. 714,756 (pages 1092-1095 of the Printed Record). Mr. Loftin comes to the conclusion that the Examiner probably allowed the Marconi application over the Stone patent because: "Stone probably intended tuning his vertical wire through varying its length, and Marconi having shown the Lodge variable acting coil as a tuning means for his vertical wire he was entitled to claim it." Will you please consider Mr. Loftin's statements as contained in the answer above referred to in connection with the File Contents of the Marconi patent No. 763,772 and state wherein your views may differ from those of Mr. Loftin?

A. I have examined the File Wrapper and Contents of Marconi patent No. 763,772 and also Mr. Loftin's statements relative thereto.

I note that he attaches considerable importance to the various statements and actions by the Examiner, but I think

that there are certain facts relative to the Examiner's knowledge which are of rather fundamental importance in considering the value of his point of view, and facts which have impressed me particularly in reading the File Wrapper and Contents.

At the time of application there was scarcely anyone, outside of Marconi himself, and a few other experimenters, who knew anything at all about radio, and the Examiner in passing upon the Marconi application, was confronted with a situation which occurs usually only at the birth of a new art and, as it happens in this case, one of the most complicated and difficult to understand, which man has yet produced.

Years of familiarity with this art constitute the only basis for qualifying a man to intelligently discuss it and determine whether or not a patent application involves new matter over the prior art. That the Examiner in the Marconi case was handicapped in this respect, and also by a lack of familiarity with some of the conditions of high-frequency circuits, is illustrated in various places in the File Contents, of which I will give examples.

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In an office action dated August 12, 1901, the Examiner replies to amendments of July 3 and 8, 1901, as follows:

"In the first paragraph of page 4 of the specification the definitions of persistent oscillators and good radiators are not sufficient. In general, a circuit which is a persistent [fol. 1296] oscillator is a poor radiator of electro-magnetic waves, and inasmuch as applicant states that his aerial circuit is the same in period as the primary circuit in which the oscillations are generated, it appears that said aerial circuit would likewise be a persistent oscillator and therefore a poor radiator. Applicant is required to further explain this feature of his invention, and accordingly claims 2, 3, 7 and 8 are objected to."

This statement is based on a complete misunderstanding of the nature of the circuits described as a persistent oscillator and a good radiator.

In general the aerial system involving an elevated conductor and commonly referred to as an "open circuit" is a good radiator, while a circuit which is closed in form; that

is, involves a condenser consisting of two or more plates very close to one another, is practically without radiating powers.

If a circuit such as the open aerial circuit of a radio transmitter is a good radiator, this characteristic is in no way affected by an association with, or tuning to, some other circuit, but remains a good radiator, because the power of radiation is a characteristic of the circuit itself, and not of any association. While this is a fact with which all radio men are familiar today, it is not at all surprising that the Examiner, acting at a time when very little experience had been had by anyone in radio, should have had an incorrect picture of these circuit characteristics.

Another illustration of this sort is found in an action dated February 11, 1902, page 4, in which claim 1 is rejected, as follows:

"Claim 1 is rejected on the first set of references cited because in each of the systems therein set out 'the time period of *electrical oscillations* in all the circuits of the transformers' may be the same, or the oscillations of the secondaries may be harmonics of the primaries. This claim covers a very different structure from that called for by claim 3. The statement above quoted from claim 1 does not imply tuning of the circuits. By forced oscillations the time periods would be the same in any of the patents cited against the claim."

It is quite obvious, in the light of present-day knowledge, that the statement in the claim referred to the period of the oscillations which the circuits themselves would have if oscillating in their own period.

Not only did the Examiner fail to recognize this, but it is evident also that the attorneys prosecuting the application were as yet unfamiliar with the art and the language necessary to exactly describe the characteristics of radio circuits.

Mr. Loftin has made a good deal of the abandonment, so-called, of the application, but a careful consideration of the facts brought out in the File Wrapper and Contents, particularly the final petition to the Commissioner for renewal, which was granted,—show clearly that great efforts were made to prosecute the application diligently, and that the lapse occurred due to the fact that Mr. Marconi was pursuing with intense enthusiasm, his great invention, and was traveling almost continuously.

[fol. 1297] While it is true that the Commissioner at first rejected the petition for renewal, yet, when a complete affidavit was presented which included all the facts, it is evident from his action that he was entirely satisfied that there had been no lack of diligence on the part of the applicant and his attorneys.

It is also very significant that after the renewal of the application all of the claims were allowed, except 4, 5, 6 and 7.

I think it may be fairly assumed, since some time had elapsed since the previous actions, that the Examiner had had more time to become familiar with the art and to appreciate the fundamental difference between the disclosures of Marconi and the prior art.

It is of interest to note the statement of the Examiner in this action relative to the Stone arrangement, he says:

"Stone shows in Fig. 5 a transformer M whose secondary L_2 is connected to an open circuit including a radiating conductor V at one end and a capacity E at the other and whose primary L_1 is connected to a condenser circuit discharging through a spark gap, viz., the circuit C s L_1 L. These circuits are in 'electrical resonance with each other',—see lines 16-20, page 2. It is not stated how the elevated conductor is given a natural period equal to that of the oscillations impressed upon it, but it is well known by all skilled in this art that this may be accomplished by adjusting the length of the elevated conductor, thereby adjusting the distributed capacity and the distributed inductance of the same until the natural period of such conductor is equal to the natural period of the condenser circuit C s L_1 L. When this is done 'the frequency impressed upon the elevated conductor' is 'the same as the natural period or fundamental of such conductor', to quote from the Stone patent.

"Applicant discloses another means whereby the same result may be effected, viz., by including a 'variable inductance' in the elevated conductor. All claims which include this element are considered allowable over the Stone patent."

It is evident from this statement that all the Examiner was able to find in Stone, in so far as the antenna circuit was concerned, was the suggestion to make the antenna wire

itself of the same natural period as the closed circuit. This statement is quite in accord with the remarks that I have already made relative to Stone, and it is also interesting to note that the inclusion of a variable inductance in the elevated conductor was considered by the Examiner in the quotation above to be something not disclosed in Stone, which statement is also strictly in accord with my own statements in this respect, and at variance with the inferences drawn by Mr. Loftin in his many uses of the Stone patent as a prior reference.

A most striking fact disclosed by an examination of the Marconi File Wrapper and Contents is that, although the Stone application and the Marconi application were co-pending, no interference was declared between them, which fact shows conclusively that they were considered to be different inventions by the Examiner.

Mr. Loftin, on Printed Record, page 1094, comments on the action of the Examiner, above referred to, and states [fol. 1298] that in his opinion had the Stone-Baker letters been before the Examiner, he would not have taken the action or have considered Stone in the light indicated by his statements. He quotes the following passage from the Stone-Baker letters in support of his contention:

"The tuning of these circuits one to another and all to the same frequency will probably be best accomplished empirically, though the best general proportion may be determined mathematically."

The significance of this statement in the Stone-Baker letters has already been pointed out, viz., that in order to know what Stone meant by it, one must examine the complete letters and the drawings illustrative of the arrangements Stone had in mind. My examination of this data has shown conclusively that Stone provided no means for tuning his antenna circuit and, therefore, for bringing all circuits in tune, and that the only possible meaning which could be given to this expression is that he intended to make the wire constituting the elevated conductor of the right length to have a natural period corresponding with his closed circuits. This is a method of procedure strictly in accordance with Stone's thought of forced oscillations, but utterly opposed to Marconi's thought, and quite useless practically.

Mr. Loftin, on Printed Record, page 1095, in commenting

further on the Examiner's action, states that the only difference which he could find between Marconi and the prior art, was the placing of the Lodge variably-acting coil in the antenna circuit, and that in his (Loffin's) opinion, this difference was an extremely narrow one.

In point of fact, however, it was a difference of a most tremendous order of magnitude, in so far as the results to a radio system were concerned; it was that difference which made it possible to have all four circuits in tune which, in turn, made possible the tremendous development of radio subsequent to Marconi's invention.

Both Stone and Tesla missed it and, as a result, failed to produce practically useful arrangements. I find that Mr. Loffin, on page 1095 of the Printed Record, admits that all of the prior art, except the Stone-Baker letters which he referred to in his deposition, was considered by the Patent Office, and I may add that since, in my opinion, the Stone-Baker letters add nothing to the prior art in any way affecting the Marconi invention, I believe the Patent Office was correct in granting to Marconi his patent No. 763,772.

One or two further points in connection with the File Wrapper and Contents occur to me. Mr. Loffin, on page 1092 of the Printed Record, quotes a statement by the Examiner in the letter of June 3, 1902, relative to the Tesla system, as follows:

"Since it is impossible to exactly calculate the values of the electromagnetic constants of two circuits for the purpose of making their time period agree, it is fair to assume that the electrical oscillator of Tesla must necessarily be made with an adjustable inductance or condenser, or both."

This statement is quite at variance with the facts in the [fol. 1299] matter of the Tesla coil. In the first place, Tesla gives instructions in the matter of building the secondary coil which are definite, and do not involve any adjustable means. Furthermore, his instructions call for making the coil of a length suitably related to the frequency of oscillations impressed thereon and, as a matter of actual construction, this length could be determined by trial until the right number of turns was found to give the very high voltages everywhere referred to by Tesla. When once found then, following Tesla's instructions, an antenna

would be attached to it, and no change made in the coil, regardless of the size of the antenna.

Tesla's instructions, as a matter of fact, are exactly contrary to adjusting of any kind, he wants the coil to be of such length as to produce the very high voltages when taken alone, and he wants the user to employ the coil so constructed, no matter what antenna he uses with it. Nothing conceivably could be farther from the thought of adjustability or from any recognition of the usefulness of this adjustability.

Mr. Loftin's comment on page 1093 of the Printed Record relative to the Tesla oscillator, which was widely known at that time, merely emphasizes the facts outlined above. It is true that the Tesla oscillator was widely known as a means for producing very high voltages and consequent spectacular displays and it is this oscillator which Tesla attempts to hook up to an antenna system, using the same arrangement with a secondary coil constructed to produce very high voltages, but failing to appreciate that the attachment of the antenna totally changed the electrical conditions previously existing.

Marconi, on the other hand, recognized all of the essential conditions, employed the necessary apparatus and accomplished wonderful results.

Q. 216. In answer to Q. 29, beginning on page 1096 of the Printed Record, Mr. Loftin made certain statements concerning the function and mode of operation of the parts of the apparatus illustrated in "Plaintiff's Exhibit No. 87, Wireless Specialty Apparatus Type" as compared with the function and mode of operation of the apparatus of Marconi patent No. 763,772. Will you please state wherein you agree, or disagree, with Mr. Loftin's statements concerning this apparatus of "Plaintiff's Exhibit No. 87"?

A. Mr. Loftin, in his testimony, Printed Record, page 1096, relative to "Plaintiff's Exhibit No. 87", identifies this apparatus as a quenched-spark transmitter of the type described in U. S. patent No. 1,216,615 to G. Seibt, and which has a mode of operation entirely different from that of the Marconi patent 763,772.

In my answer to Q. 199, I have, I think, very clearly shown that the quenched-spark transmitter system is, in fact, the system of the Marconi patent 763,772, and that it embodies the same essential elements, viz., an open radiating cir-

cuit, a closed reservoir circuit and tuning between these two circuits. I have also shown that the Seibt system was considered by the patentee to involve resonance and tuning between the close and open circuits, and have cited refer-[fol. 1300] ences from the File Wrapper and Contents expressive of this fact.

Mr. Loftin further describes the apparatus of "Plaintiff's Exhibit No. 87" as being based upon the Lodge patent 609,154 in suit, particularly Fig. 4, with improvements in the matter of the spark-gap used, as the result of Seibt's work.

As I have already shown in answer to Q. 209, Lodge patent 609,154 disclosed an arrangement in Fig. 4 which is not only inoperative as shown by actual tests, for the purpose of carrying out Lodge's thought of "impulsive rush", but was not usefully operative in any other sense, since less effective than the original Marconi patent 11,913.

Furthermore, I have shown in my answer to that question that the sort of energy-transfer from one circuit to another contemplated by Lodge has never actually been realized in a substantial commercial arrangement. In explaining the action of this sort of transfer, I have, in that answer, illustrated the results of some laboratory experiments and showed that the curves representative of the electrical motion in the circuits of the experiment were quite different from those of the quenched-spark transmitter. The actions taking place in a quenched-spark transmitter are wholly unlike those of the Lodge Fig. 4 and entirely different from Lodge's theory, unrealized by his actual apparatus. As I have shown in answer to Q. 199, in the quenched spark-gap transmitter there is a resonant transfer of energy from the closed circuit to the open circuit, and this resonance is demanded, both by the theory of operation, and by the facts of actual use.

This answer, viz., my answer to Q. 199, develops theories and facts which are in complete contradiction to Mr. Loftin's statement at the bottom of Printed Record page 1097 and the top of page 1098, that there is no such thing as resonance between the primary and secondary circuits of the quenched spark-gap transmitter, and his further statement at the top of page 1098, to the effect that the adjustment of the time periods of the circuits is for a purpose having nothing to do with a resonant transfer of energy between the circuits.

The facts shown by innumerable tests are conclusive relative to the tuning of the quenched spark-gap transmitter and show that these circuits *must* be tuned for proper operation, while the simple theoretical analysis given in my answer to Q. 199, clearly brings out the reasons why they are tuned, viz., in order to transfer the energy.

Mr. Loftin, in commenting, at page 1097 of the Printed Record on the Lodge system, distinguishes it from the Marconi system on the basis that whereas, in the Marconi system the frequency of oscillations was determined by the closed circuit in the Lodge system, the primary circuit has nothing to do with the frequency and duration of the oscillations. This comment is based entirely on the statements in words of the patent, while the facts disclosed by the actual working of the arrangement in the patent are entirely at variance with the hopes expressed therein, and show that in so far as the principal wave length radiated by the Lodge system is concerned, the primary had a great [fol. 1301] deal to do with the frequency radiated, while the antenna coils L^1 , L^2 , of Fig. 4 of the patent, which should be the determining elements if this figure worked as Lodge thought it would, have nothing whatever to do with the principal wave length radiated.

I can only conclude from my knowledge of the operation of the Lodge system and of the quenched spark-gap systems derived from actual experimental use in the case of the Lodge system, and very long practical experience in the case of the quenched spark-gap transmitter, that the latter, an operative and efficient arrangement, is not based on the former, a practically useless arrangement and, in fact, is not in any way related to the Lodge system, except in the use of the Lodge variably-acting inductance coil.

Mr. Loftin, on page 1098, in referring to the quenched spark-gap transmitter of "Plaintiff's Exhibit No. 87", again takes up the matter of two oscillations of different frequencies, resulting from the tight coupling of two oscillatory circuits together, and attempts to conclude from this that the purpose of resonance in tuned coupled circuits in which a quenched spark-gap is employed, is the production of beats, rather than the transfer of energy, which conclusion to me is analogous to concluding that a pump handle is operated for the purpose of producing squeaks; whereas, it is actually operated for the purpose of getting water out

of the ground and the squeaks are merely an incidental result of that action.

So in the quenched spark-gap transmitter the circuits are tuned and coupled together for the purpose of getting the electrical energy out of the closed circuit and into the open circuit, where it will be effective and useful in radiating into space, and as an incident to this action the wave form illustrative of the motion of electricity in the closed circuit takes that form which is sometimes described as "beat".

The two frequencies resulting from the tight coupling are not the cause of anything, but are merely the result of a particular wave form. They have nothing whatever to do with the transfer of energy between the two circuits, since, as shown in my answer to Q. 199, the transfer of energy between resonant circuits requires merely that the resultant motion of electricity in the driving circuit shall occupy a time for each swing which corresponds with the resultant motion of electricity in the driven circuit, a condition which is realized when the two circuits are in tune, and only then.

While Mr. Loftin, on page 1099 of the Printed Record, refers to Seibt and his work as though it supported his contention that resonance did not exist between the closed circuit and the open circuit, the statements contained in the Seibt File Wrapper and Contents, already referred to, indicate that Seibt thought quite otherwise. He quotes the following from the Seibt patent:

"From the moment of this snapping off of the current at the spark gap, or the resulting opening of the primary circuit the secondary circuit takes up an independent oscillation, uninfluenced to any appreciable degree by the coupling there of to the primary circuit, the character of the oscillations therein being changed so that the two coupled waves n_1 and n_2 disappear and the free oscillation n_0 alone, of the secondary circuit takes place, this free oscillation being of slowly damped form and depending on the natural period of the secondary circuit."

and comments on this quotation by stating that two arbitrary coupling frequencies exist and act to create a point of no energy or beat. He illustrates this action, Fig. 6, "Loftin Sketch O", opposite P. R., p. 1100, by showing two curves, one in green and one in red. Either of these

curves taken alone would illustrate correctly the electrical motion in a closed circuit of a quenched spark-gap, but the two together are not representative of the actual motion. His statement above referred to, that the two oscillations interact to produce a beat, is an inversion of the facts, a putting of the cart before the horse, because the two frequencies do not cause the beat, but are the result of the beat; that is, are the components of the particular wave form which results when the oscillations in a closed circuit are rapidly reduced to zero; and physically, there is only one sort of motion taking place in a closed circuit employed with the quenched spark-gap transmitter, and that is the sort of motion which could be correctly indicated by one or the other of the curves of Fig. 6 of "Loftin Sketch O", opposite page 1100 of the Printed Record.

While, as I have already pointed out, the term "beat" is used in connection with that type of wave form which waxes and wanes, it is incorrect to use it in connection with the sort of motion indicated by one of the curves of Fig. 6, for the reason that there is not true waxing and waning indicated here, but simply one period of waning.

Mr. Loftin, on page 1101 of the Printed Record, extends his explanation of the quenched-gap action and brings out the fact that the oscillations of the antenna circuit, after the spark-gap has quenched or gone out, continue in accordance with the natural period of the antenna itself, and concludes with the statement as follows:

"It is seen that this is a system entirely different from that described by Marconi, which Marconi system has been termed by the art the 'open gap system'."

With this conclusion I disagree most emphatically, for reasons extensively set forth based, I believe, on a sound foundation.

Mr. Loftin continues, page 1101 of the Printed Record, to differentiate between the Marconi system and the quenched-gap system. He states:

"In the open gap system, no beats are produced, first, because it is required that the primary circuit determines or sets the pace for the one frequency of the system and to produce beats there must be two frequencies."

My own experience with open gaps of various kinds has indicated conclusively that the production of the so-called

beat is not the property of the quenched-gap alone but, on [fol. 1303] the contrary, that all types of spark-gaps have this same characteristic and that the difference between them is only one of degree.

In all cases the best adjustment in practice is that adjustment of the coupling which is sufficiently close to extract the maximum energy without being too close and thereby allowing the open circuit, by its action on the closed circuit, to re-ignite the spark gap, and so produce the complex-wave form. When this adjustment is effected the oscillations in the closed circuit will be reduced down to zero and then stop, in the manner shown in Fig. 6 of "Loftin Sketch O", either the red or green curve alone, but in the case of the open gap, more oscillations will take place in this circuit than when the quenched gap is used. This does not mean that the gap has anything to do with the number of oscillations which take place, because that is determined by the coupling, but the more effectively the gap cools, the more closely may the circuits be coupled, without re-igniting the gap.

Recognition of this action of the gap is shown in the work carried on continuously and referred to by witnesses in this case directed toward improving the means for cooling the gap and the quenched gap is merely the most satisfactory solution of this problem up to the present time. In this quotation Mr. Loftin again refers to the two frequencies as the cause of the beat, and not, as is actually the case, as the result.

He gives as his second reason for differentiation (P. R., p. 1101):

"* * * because the primary must be persistent and have its oscillations drawn out for a long time, and it cannot be persistent if it quickly transfers all of its energy to the secondary to produce the beat required in the quenched gap system, and the oscillations in the primary will not be long drawn out; * * *"

This statement is a repetition of Mr. Loftin's oft-repeated contention that the Marconi system must be persistent and have the oscillations drawn out for a long time.

As I have frequently stated, in the course of my testimony, there is nothing in the Marconi patent, which I can find, or which Mr. Loftin's testimony has called my atten-

tion to, which requires that the oscillations in the primary circuit should be persistent or long drawn out, but merely the use of the term "persistent oscillator" to describe a form of circuit when considered by itself; a form which is the same in the Marconi patent and in the quenched spark-gap transmitter. The persistence, or otherwise, of the oscillations in the closed circuit of the transformer, is determined by the degree of coupling with the secondary circuit; the closer the coupling, the fewer the oscillations, and *vice versa*.

Mr. Loftin gives a third basis for differentiation (P. R., p. 1101), as follows:

• • • • • third, because in the open-gap system, the primary must act as a reservoir and slowly feed energy to the secondary to persistently make up for the energy expended by the secondary in radiating for useful communication, whereas in the quenched-gap system the energy is quickly [fol. 1304] dumped into the secondary during which period there is no useful radiation, and when the secondary is usefully radiating, the primary is entirely out of action and supplies no energy; • • • • •

This statement starts by requiring the primary of the Marconi system to slowly feed the energy to the antenna, while it describes the action of the quenched-gap circuit as being a quick dumping of the energy into the secondary circuit.

These are distinctions and differences existing only in Mr. Loftin's language since, in fact, there is no requirement upon the closed circuit of the Marconi arrangement that it should slowly feed the energy to the secondary circuit, and the practical use of the Marconi arrangement has always involved a transfer of this energy which is as rapid as the spark-gap will permit. On the other hand, in the quenched spark-gap transmitter the energy is by no means quickly dumped into the antenna circuit, but requires, usually, quite a number of oscillations:—somewhere about ten, as I recollect my experience—while, if the energy were quickly dumped, as described by Mr. Loftin, there would exist in the primary circuit a "pulse" of the sort shown in "Claimant's Exhibit No. 248", Fig. 2, for instance, page 76, and the upper curve of this figure.

A fourth distinction given by Mr. Loftin (P. R., p. 1101), is as follows:

“* * * there must be a resonant transfer of energy between the primary and the secondary in the open-gap system, because the primary is always and continuously supplying energy at a particular desired frequency to the secondary, and the secondary must have the same natural period of oscillation as the frequency of the oscillation from which it is being fed to obtain an efficient transfer at the slow rate of feeding, whereas in the quenched gap system there is no resonant transfer, the energy merely quickly going over at two widely separated frequencies, neither one of which corresponds to the natural period of either the primary or secondary circuit.”

In this statement Mr. Loftin again requires the Marconi arrangement to be “always and continuously supplying energy at a particular desired frequency to the secondary.” The Marconi patent 763,772 says nothing about any necessity for acting in this particular way and experience with its use indicates that such is not the fact. The patent, furthermore, says nothing about the transfer of energy at a particular frequency, and the physical facts relative to the transfer of energy in this manner are, as already stated, that that thing which is technically and mathematically known as a frequency, has nothing to do with the efficient transfer between two circuits oscillating in their own natural manner.

There might perfectly well be a dozen frequencies; that is to say, a wave form of such shape that it was analyzable into a dozen frequencies; yet, so long as the time-period of the driven circuit corresponded with the time-period of the resultant motion of the electricity in the driving circuit, resonance between the circuits would be the controlling element of transfer of this energy.

[fol. 1305] This statement is an answer to Mr. Loftin's statement in the above quotation, relative to the secondary having the same natural period of oscillation as the frequency of the oscillation from which it is being fed. Mr. Loftin's concluding statement, of course, shows the reason for his attempt to confine the Marconi arrangement to a transfer of the energy at one frequency, because in this statement he differentiates the quenched-gap arrangement

by stating that the energy goes over quickly at two widely separated frequencies. This is a distinction based, first of all, on the use of the term "frequency" in a way which is quite misleading and, secondly, on a mode of operation of the Marconi arrangement which is incorrect in point of fact. Actually, and for the moment, using Mr. Loftin's own language, the coupling in a properly-operated open-gap set of the Marconi type is of such closeness that the primary oscillation dies down to zero, while the secondary oscillation continues for some time thereafter.

This is the transfer of the energy by means of two frequencies in Mr. Loftin's language, and it differs from the action of the quenched-gap transfer solely in the fact that the primary oscillation dies out more slowly, due to the less perfect cooling of the gap, and the "two frequencies" are not so different from each other as with the closer coupling and the quenched gap. This language, however, is technically incorrect as a means of describing the action taking place when energy is transferred between two circuits, since it is the resultant motion of the electricity, which may be analyzable into many frequencies, and its relation to the natural time-period of the two circuits which determines the transfer.

This, of course, goes somewhat into theories which are difficult to understand, and to my mind the whole story is best summed up in the statement that the coupled circuits of a spark transmitter, regardless of the type of spark, have to be tuned to get good results; when this is done, the requirement of the Marconi patent, viz., the product of the inductance and capacity in one circuit equals the product of the inductance and capacity in the other circuit.

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On Printed Record page 1107 Mr. Loftin summarizes his point of view relative to the transmitter of "Plaintiff's Exhibit No. 87", and states that it is entirely different from the transmitter of the Marconi patent No. 763,772, which he incorrectly designates as the open-gap type. His summary is divided into five parts, and in the first he states that the [fol. 1306] apparatus of "Plaintiff's Exhibit No. 87" is based upon the principle of Lodge, viz., quickly dumping the energy into the radiating circuit, and then disconnecting the closed circuit, while the Marconi transmitter requires that oscillations be maintained for a long time in the

primary circuit. As I have already pointed out, Lodge does not function in the manner hoped for by Lodge, and stated by Mr. Loftin, but in a non-descript and useless manner.

As I have also already pointed out, the quenched spark-gap neither operates on the basis of Lodge's principle, nor his apparatus but, on the contrary, functions in exactly the same way as a Marconi transmitter with an open spark-gap, the difference in the spark-gap not resulting in a different mode of action, but merely an improvement in the mode of action of the open gap.

His second point again contains the statement relative to the energy going over in two frequencies but, as I have already pointed out, this incorrect description in the method of transfer of the energy between the closed and open circuits, if used at all, applies equally well to the open gap as to the quenched gap.

His third point is his oft-repeated statement that the arrangements for the adjustments of the two circuits; that is, the tuning adjustments, are for entirely different purposes; that is, in the case of the Marconi transmitter, for the purpose of transferring the energy; while in the quenched-gap, it is for the purpose of producing a beat.

This statement is, of course, nonsensical and the purpose of tuning in both open-gap Marconi gap transmitters and quenched-gap transmitters is to get the energy over into the open circuit as efficiently as possible, which is the same thing as saying as quickly as possible; since, the longer it circulates in the closed circuit the more energy is there wasted in this circuit, and the less available for radiating purposes. The so-called "beat" is an incident in the operation of both types of gap and the difference between the two types is merely that the so-called "beat" is shorter with the quenched-spark than with the open spark.

His fourth point states that the quenched-spark system depends upon a tight coupling between the two circuits,—a statement which is entirely incorrect, because the quenched spark system will operate with a wide variety of couplings functioning in exactly the same manner with all of them, but becoming more efficient as the coupling is closed up.

In general, the maximum coupling usable with the quenched-gap is about twenty per cent, while the maximum coupling which I recollect as being embodied in the Mar-

coni arrangement, that is to say, the actual constructions outlined in the patent, is about nineteen and a half per cent.

The action of a Marconi tuned coupled transmitter with the quenched-gap is the matter of different couplings, is identical with the action of the same transmitter with an open type of gap, and in both cases the coupling is made as close as possible, without re-ignition of the spark gap.

In this point Mr. Loftin again refers to the two frequencies as being an object of the adjustment; whereas, as a matter of fact, they are merely an incidental result.

[fol. 1307] His fifth point is that when the quenched-gap is employed as part of the tuned coupled transmitter and signals from it are received by a two-circuit receiver, that the resulting system is a three-circuit system, since the spark-gap circuit only acts for a small part of the time. This is a most peculiar reasoning, and its fallacy is so obvious that it hardly seems to need comment. Nevertheless, I will merely state that under the circumstances above specified, the complete radio system consists of four circuits, two at the transmitter, two at the receiver, and all four tuned to the same time-period. Of course, the Marconi patent says nothing about how long the closed circuit shall remain in action, but merely specifies its use. There is also the additional technical fact that the quenched-gap does not differ from any other type of gap in the matter of cutting off the oscillations in the primary circuit, except in degree. That is to say, it will stand a closer coupling without re-ignition and, therefore, fewer oscillations in the closed circuit.

On page 1109 of the Printed Record Mr. Loftin takes up the receiving system of "Plaintiff's Exhibit No. 87", but prefaces his remark by a repetition of his statement already answered, that the complete system is a three-circuit system. He introduces an additional statement to the effect that the Marconi open-gap system requires a precise adjustment, while the apparatus of "Plaintiff's Exhibit No. 87" requires only three adjustments.

This statement is entirely contradictory to the facts, since in both cases, as I have many times pointed out in my deposition, all four circuits are in tune; are found to be in tune by extensive practical experience, and the precision of adjustment required with either the open-gap or quenched-gap is the same.

I may say in this respect that I have used in the same arrangement; that is, the same transmitter, antenna, etc., first an open-gap and then a quenched-gap, adjusting both for best results, and found that the tuning adjustments necessary to bring the two circuits into tune were the same in both cases.

The quenched-spark apparatus, contrary to the statement of Mr. Loftin, and for reasons already given, bears no resemblance to the Lodge arrangement, either in theory or in action, except that it employs the Lodge variably-acting coil.

Mr. Loftin's further statement on this page, to the effect that Lodge implied tuning in the secondary of his receiver, has already been contradicted in my previous answers, and the same remarks apply to his statement at the bottom of this page, that the Marconi 1899 patent disclosed a tuned secondary circuit.

Q. 217. Will you please state whether or not you agree with Mr. Loftin's answer to Q. 30 of his deposition on page 1109 of the Printed Record, as to the matter of the relation of the Wireless Specialty type of apparatus to the language of the individual claims sued on in Marconi patent No. 763,772?

A. I do not agree with Mr. Loftin's statements but, on the contrary, consider that the Wireless Specialty type of apparatus completely meets the requirements of the claims referred to.

While Mr. Loftin, in his reply to Q. 30, sets forth in de-[fol. 1308] tail the reasons for his opinion, his statement includes no points which are new, and which I have not already answered in my detailed consideration of these claims and the mode of operation of the quenched spark-gap type of transmitter. I will therefore content myself with the general statement that, in my opinion, the reasons set forth in Mr. Loftin's answer to Q. 30 for his belief that the apparatus of "Plaintiff's Exhibit No. 87" is not covered by the claims of the Marconi patent 763,772 do not rest on a sound basis of either technical fact or the state of the prior art at the time of the Marconi application.

Q. 218. Referring to Mr. Loftin's answer to Q. 32 on page 1117 of the Printed Record, will you please state whether or not you agree with Mr. Loftin's statements concerning the "Atlantic Communication Company Type" and the

"Signal Corps Pack Set, 1915 Type"? Please give your reasons for your answer.

A. I do not agree with Mr. Loftin's statements on Printed Record page 1117 relative to the Atlantic Communication Company Type of receiver and the Signal Corps Pack Set receiver. Mr. Loftin quotes Mr. Waterman's statement relative to the capacity of the coil supplying the necessary capacity for tuning and states the same line of argument would lead to the conclusion that the Lodge secondary winding is a tunable circuit. No such conclusion is warranted or justified. The Telefunken type of receiver is made adjustable as to the number of turns, and this number of turns is so chosen that each tap is broadly tuned over a small range.

As I have previously pointed out in answer to Q. 202, a secondary circuit of the receiver containing a crystal detector, may be broadly tuned, and this is particularly true when the only capacity in this circuit is the inherent capacity of the coil, which is small.

With the method of connection of the detector to this circuit, such as that employed in the Telefunken receiver, the effect of the crystal detector is to add a large damping to the receiver circuit and make the tuning quite broad. In order, however, to take advantage of this situation, knowledge relative to the benefit of tuning this circuit, as was disclosed by the Marconi patent, is necessary. That Lodge was not aware of the benefits of such tuning, and did not employ it, has already been pointed out, and while it is true that the secondary coil of his receiver would have inherent capacity, this fact does not signify tuning. Had Lodge been aware of the benefits of tuning he could have adjusted the number of turns in his secondary coil and provided this with some variably-acting adjusting means, as in his transmitting coil; or, rather, as in the coil included in the antenna circuit, and so have secured tuning. It is no more correct to infer that he might have tuned his secondary circuit in this way than to infer that he might have tuned it with a condenser. Since he did neither of these things, I am unable to consider that Lodge has any bearing on the Telefunken receiver.

In so far as the Signal Corps Pack Set of "Plaintiff's Exhibit No. 91" is concerned, I am of the opinion that the short-wave arrangement shows two tuned circuits, one con-

sisting of the antenna, the two coils marked "Primary" and the ground, and the other—the secondary circuit—consisting of the two coils marked "Primary", the two condensers marked "Fixed Coupling Condensers" and the coil marked "Secondary". The two coils marked "Primary" allow of the independent adjustment of the antenna circuit, since they are variable, while the variable coil marked "Secondary" permits the tuning of the secondary circuit.

In so far as the coupling is concerned, it will be seen that the two coils marked "Primary" are common both to the antenna circuit and the secondary circuit and therefore constitute a direct coupling, which Mr. Loftin has admitted is equivalent to the inductive coupling of the Marconi patent No. 763,772.

While there are two condensers marked "Fixed Coupling Condensers", I am unable to see how they are capable of functioning for this purpose, in the location shown, but appear to me merely to supply the necessary capacity in the secondary circuit to tune with the secondary inductance.

In so far as the figure marked "Long Wave Lengths" is concerned, I am unable to state from the available information, whether or not the secondary circuit is tunable.

Q. 219. On page 1118 of the Printed Record, Mr. Loftin criticizes the diagrammatic sketches constituting "Plaintiff's Exhibit No. 79" (Telefunken Apparatus); "Plaintiff's Exhibit No. 101" (Lowenstein Apparatus) and "Plaintiff's Exhibit No. 102" (Foote-Pierson Pack Set), as illustrating two windings, one in black and one in red. Please state whether or not you consider Mr. Loftin justified in so interpreting the diagrams of these exhibits, and if not, why not?

A. Mr. Waterman, in his testimony, on page 181 of the Printed Record, has very clearly stated that the coil which he has shown in red and black has only one winding, but that the two colors are used simply to distinguish the two circuits, viz., the open circuit and the closed circuit, both of which go through this coil, from each other. It appears, therefore, that Mr. Loftin's statement on page 1118 of the Printed Record is without justification from the testimony of Mr. Waterman.

Q. 220. Referring to Mr. Loftin's testimony concerning the apparatus at the receiving station, involving the Telefunken type and the Foote-Pierson type of apparatus,

please state whether or not you agree with Mr. Loftin that these receivers "had untunable secondary circuits". Please consider "Plaintiff's Exhibits Nos. 79" and "102" and Mr. Loftin's testimony on Printed Record page 1119 relative thereto.

A. Mr. Loftin has referred to these two receivers illustrated in "Plaintiff's Exhibit No. 79" as E 4, and "Plaintiff's Exhibit No. 102", the right hand figure, the former being the Telefunken receiver, and the Foote-Pierson Pack Set.

The drawing E 4 shows a variable secondary winding and happens to be a type of Telefunken receiver with which I am familiar, and which I have tested numerous times. This secondary receiver has taps brought out to a plug-type of switch and the length of winding is so adjusted for each tap that it is broadly tuned over a certain range; the different taps in the coil serve to cover the entire range which the receiver is designed for.

The Foote-Pierson type shown in "Plaintiff's Exhibit [fol. 1310] No. 102" is direct-coupled, and the antenna circuit is tunable by means of the variable contact point 4, while an adjustment of the variable contact point 5 will connect in circuit a number of turns which, in connection with their own capacity, will tune the circuit.

In general it will be found that more of the coil will be included by tap 5 than by tap 4, when the circuits are in tune.

I therefore disagree with Mr. Loftin's statement to the effect that these two receivers have secondaries of the untunable type, and state, on the contrary, that I consider both of these secondaries to be tunable, and to have the means necessary for tuning described in the Marconi patent 763,772.

Q. 221. On page 1120 of the Printed Record, Mr. Loftin refers to the testimony of George H. Clark as found on page 239 of the Printed Record, concerning wave changers. And on page 1121 of the Printed Record he states that the adjustment of the inductance of the two circuits in which the device was connected, does not mean that the adjustment was for the purpose of securing resonance between these two circuits, as contended by Mr. Waterman. Will you please state briefly what experience you have had with such wave changers as referred to by Mr. Waterman and Mr. Loftin and in view of your knowledge of the operation

of wave changers, will you please state in what respects you may disagree with Mr. Loftin? Please also refer to the rebuttal deposition of George H. Clark wherein, in answer to Q. 40, he refers to the same subject, and state whether you agree with Mr. Clark.

A. It happens that I have had a great deal of experience with the type of wave changer referred to by Mr. Clark in his testimony and, in fact, designed by him.

During the War the Marconi Wireless Telegraph Company of America built large numbers of quenched spark-gap transmitters of the type referred to, having wave changer switches and during this time I was Chief Engineer of the Marconi Company, and supervised the work of design, manufacture and testing of these wave changers.

Mr. Loftin, in his comment on Mr. Clark's testimony, goes rather extensively into a description of the apparatus and then states, Printed Record, page 1121, as follows:

"* * * The mere fact that these wave changers included arrangements for adjusting the inductance of the two circuits in which the device was connected does not mean that the adjustment was for the purpose of securing resonance between the two circuits as contended by Mr. Waterman, for in the quenched-gap type, resonance between the two circuits is not used, and the adjustments are for an entirely different purpose."

This statement is merely Mr. Loftin's oft-repeated contention that the circuits of the quenched-gap transmitter are not tuned, and it seems sufficient for me to state that I know from my own long experience, that they are tuned.

Mr. Loftin makes the statement to the effect that if the wave changers were for the purpose of securing resonance, they would apply equally well to the prior art, but it does [fol. 1311] not appear to me that there is any particular connection between the wave changer switch and the prior art on the Marconi patent No. 763,772.

The wave changer switch is simply a convenient means of connecting the right number of turns in the primary circuit and the right number of turns in the secondary circuit for different wave lengths, in order that these two circuits may be in tune.

Q. 222. Will you please refer to Mr. Loftin's answer to Q. 33 on page 1124 of the Printed Record and "Loftin Sketch P", inserted opposite said page, and after examining "Plaintiff's Exhibit No. 98" will you please state whether Mr. Loftin's diagram purporting to illustrate the circuits of the Foote-Pierson Pack Set is correct, and if not, please state how it is incorrect, and submit a correct diagram?

A. I have examined "Plaintiff's Exhibit No. 98", which I understand represents the Foote-Pierson Pack Set", and contains a wiring diagram of the transmitter and receiver connections. I have traced out these connections and I find that the receiver circuit connections shown on "Loftin Sketch P" do not correspond to the receiver connections shown in "Plaintiff's Exhibit No. 98".

I produce "Weagant Sketch No. 3" (Claimant's Ex. 251), which sketch shows the receiver connections as I find them in "Plaintiff's Exhibit No. 98". An examination and comparison of the two sketches, viz., "Weagant Sketch No. 3" and "Loftin Sketch P" shows that in the former there is a circuit P, R, connected around the stopping condenser H and in the latter that this same circuit is connected around the detector.

It will also be noted in "Weagant Sketch No. 3" that the telephones have one terminal which connects directly to ground; whereas, in "Loftin Sketch P" one terminal of the potentiometer is connected to ground.

Q. 223. In view of the differences you have pointed out between "Loftin Sketch P" and "Weagant Sketch No. 3" which, you have stated, shows correctly the circuit connections of "Plaintiff's Exhibit No. 98", will you please point out whether or not the circuit at the "Receiving Station" of "Weagant Sketch No. 3" is within the terms and spirit of the claims of Marconi patent in suit No. 763,772, relating to receiving apparatus?

A. The receiving apparatus of "Weagant Sketch No. 3" complies with the requirements of the claims of the Marconi patent No. 763,772, particularly claims 2, 13, 14, 16, 17, 18 and 19.

Mr. Vaill: Counsel for claimant offers in evidence the [fol. 1312] sketch produced by the witness and marked "Weagant Sketch No. 3", as "Claimant's Exhibit No. 251".

(Said exhibit so marked.)

Q. 224. Will you please refer to Mr. Loftin's answer to Q. 35, beginning on page 1125 of the Printed Record, and state wherein you may agree or disagree with the statements in the publications referred to by Mr. Loftin in that answer?

A. Before taking up in detail the publications referred to by Mr. Loftin in his answer to Q. 35, there are certain facts characteristic of a number of them, to which I wish to call attention.

Examination of the article by Fleming, in the London "Electrician", June 11, 1909 ("Defendant's Exhibit B-5"), the article in "Electrician", November 10, 1911 ("Defendant's Exhibit C-5"), which is unsigned, the Zenneck "Wireless Telegraphy", 1915, translated by Seelig, page 94 ("Defendant's Exhibit D-5"), and the book entitled "Wireless Telegraphy and Telephony", by Eccles, 1918 ("Defendant's Exhibit E-5"), discloses the fact that the diagram entitled Fig. 1, in the article by Fleming, which purports to show the action taking place in closely coupled transmitting circuits with an open spark-gap and closely coupled transmitting circuits with a quenched spark gap, is the same in all of these articles.

The same figure is also used in the article by Count Arco, referred to by Mr. Fleming in his paper of "Defendant's Exhibit B-5". This examination also discloses the fact that the information contained in these articles is of substantially the same nature and these facts bring out the important point, well known to technical workers, that technical writers have the habit of embodying in their own works information which is largely obtained from some other writer and which is based on very little in the way of actual experience of their own.

In none of these articles is there any statement of extensive use of the quenched spark-gap system, or anything suggestive of such extensive use, except the unsigned article in the "Electrician" of November 10, 1911, "Defendant's Exhibit C-5".

This is in striking contrast with the sort of thing which is back of the statement, for instance, in the Navy Manuals, and which I have previously quoted. Also a very different thing from the long practical experience, such as that of

the witness, George H. Clark in this case, and of the present witness.

[fol. 1313] Gentlemen like Dr. Eccles, Prof. Fleming and Dr. Zenneck, are College Professors, and when investigating a subject like that of the quenched spark-gap transmitter as a rule, have neither the time, interest or facilities approaching those of the practical man working for a large institution such as the Government, or a commercial organization, and whose work is dominated by the necessity of making the apparatus work as efficiently as possible.

Referring once again to the diagram of Fig. 1, I wish to point out that this particular diagram has been used by practically everyone who has written about the quenched spark-gap, and it seems to me of interest at this point to present a few facts relative to its origin.

A search of the literature seems to indicate that its first appearance was in Zenneck's book on "Wireless Telegraphy", page 94, of Seelig's translation, "Defendant's Exhibit D-5", and the only supporting technical data for Fig. 131 is the oscillograph photograph of Fig. 132, and supporting technical data is given for Fig. 130 in Zenneck, namely, an oscillogram by Diesselhorst. I find, also, in the paper by Count Arco, the statement to the effect that the same figure in his paper is based on an oscillogram by Diesselhorst.

It will be noted that in Fig. 130 and Fig. 131 the number of oscillations in the primary circuit is the same,—which, to say the least,—is a most remarkable coincidence. That two different experimenters, working independently, should so adjust their circuits, and particularly the coupling, as to correspond in this exact way, is incredible.

The oscillogram of Fig. 132 is stated by Zenneck to have been due to H. Rau, but an examination of his paper fails to disclose the necessary technical data to enable an Engineer to determine the nature of the apparatus; that is, the quenched-spark apparatus, from which this oscillogram was made, and from my experience with matters of this kind, I unhesitatingly pronounce the oscillogram of Fig. 132 as without significance.

Fig. 130, as previously mentioned, is based on an oscillogram by Diesselhorst which is shown by Zenneck on page 89 of "Defendant's Exhibit D-5", Fig. 124 and it is evident from an inspection of this figure that it is rather difficult to identify, with any degree of exactness, the curves

of Fig. 130 with the result shown in the oscillogram of Fig. 124.

In spite of the lack of sound fundamental technical data on which to base Figs. 130 and 131, these two diagrams have been used to explain the quenched spark-gap action and its relation to the open spark-gap for many years, and have created impressions relative thereto which, in my opinion, are not in accordance with the facts.

As an illustration of the general nature of the phenomena when a closely coupled open spark-gap and a closely coupled quenched spark-gap are used, it is all right in that it brings out the fact that the quenched spark-gap cuts off at the first point of zero amplitude of the primary oscillations, but it is quite incorrect, in so far as showing the actual number of oscillations which take place in the primary circuit.

[fol. 1314] While I do not find in any of the literature any statement that the number of oscillations so shown is representative of the actual facts, nevertheless, I do know that this diagram has been accepted by many workers in the art as such an actual representation.

My own experience indicates that in the quenched spark-gap circuit the number of primary oscillations is some nine or ten and I recollect that Dr. Zenneck, the author of the text-book "Wireless Telegraphy", testified in the Kilbourne & Clark case, as follows (Printed Record, p. 3615):

"Q. You testified in that case as follows, did you not:

"X Q. 47. How many complete periods of oscillations in the primary circuit of the Sayville transmitter do your decrement measurements prove to have existed before the oscillations were damped down to 10 per cent of the maximum?

"A. I have not calculated this.

"X Q. 48. Could you do so?

"A. Yes, I could do it, but it would take some time. It is very easy to calculate it.

"X Q. 49. Could you do so in a few minutes?

"A. I can give you the formula and perhaps you could calculate it yourself.

"X Q. 50. I would prefer, Dr. Zenneck, if you would calculate it and state what the result is from your own formula?

'A. Yes, I can do it. If I have not made a mistake the result is 9.2. That would mean that after nine periods, the amplitude of the current is about one-tenth or 10 per cent of the initial amplitude.'

"You remember so testifying?"

"A. I remember that I testified in this way." • • •

I also recollect that I heard Dr. Zenneck give this testimony in the suit of the Marconi Wireless Telegraph Company of America *vs.* The Atlantic Communication Company, which testimony was introduced into the Kilbourne & Clark case and is quoted above.

The Sayville station, as I have previously pointed out, employed a quenched spark-gap transmitter of large power, and I have personally inspected the apparatus and seen it in operation.

As will be seen, Dr. Zenneck's own statement while testifying under oath, corresponds with my own figure, and is quite different from his own diagram of Fig. 131, which shows only three and a half oscillations.

The article in the "Electrician" of November 10, 1911, which is unsigned, is one with which I have long been familiar, and is in the nature of advertisement and propaganda, such as is commonly employed by commercial companies to bring their goods to the attention of the public.

There is also a further point to be considered in connection with this article, viz., that the Telefunken Company, whose apparatus is herein described, was a large German commercial organization and, in the employment of their system, that is, the quenched spark-gap system, was obliged to meet the situation created by the existence of the Marconi tuning patent, No. 763,772, and corresponding patents in foreign countries. There was obviously, therefore, the strongest possible reason for the presentation [fol. 1315] of statements tending to differentiate their system from that of the Marconi Company, and the Marconi patent.

Since tuning between all four circuits is such a vital part of the Marconi system, any lack of such tuning which could be shown in the Telefunken system would support their position. Fig. 3, on page 172 of the "Electrician" of November 10, 1911, "Defendant's Exhibit C-5", is a curve which purports to show the necessity for mistuning

and is, I believe, the basis for the widespread belief amongst many technical radio workers that such a mistuning was a necessity and one of the first things which I had to determine when I first took up quenched spark-gap work—some time about 1911 or 1912—was the correctness, or otherwise, of this curve.

My experimental work very soon showed that the curve was incorrect; a fact which has been further conclusively substantiated by many years of extensive practical experience with the quenched spark-gap. Not only did this experience show that the information contained in Fig. 3 was false, but it also showed just how this information was obtained.

Referring now to Zenneck's "Wireless Telegraphy", "Defendant's Exhibit D-5", there are two statements of great significance, one of which is that quoted by Mr. Loftin on Printed Record, page 1130, as follows:

"The pureness of the pulsations probably also plays a part in the explanation of the fact that by bringing the primary and secondary circuits slightly out of resonance, a pure quenching can be obtained, after the quenching has been spoiled with primary and secondary entirely in tune."

and which he contends supports his statements relative to mistuning, and another, which is quite different, from page 96 of his book:

"b. Pureness of the Pulsations. It is most favorable for the quenching action if the amplitude of the resultant oscillation in the primary circuit really becomes *zero* after the first half pulsation, that is, if the pulsations are pure. The essential condition for this, however, is that both oscillations, after half a pulsation, have the same amplitude but are opposite in phase.

"Whether this condition obtains depends upon the accuracy of the tuning between the primary and secondary circuits; the more exact the tuning, the purer will be the pulsations, other things being equal." (Fig. 133.)

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"Moreover, even with perfect tuning, it is evident that the pureness of the pulsations depends upon the initial implitude of the two oscillations and their decrements."

This latter statement is perfectly clear to the effect that in order to obtain a pure pulsation, that is, in order that the primary current may be reduced at zero, which is the condition stated by Zenneck for good operation of the quenched spark-gap, the circuits must be perfectly tuned.

The first statement by Zenneck, referred to by Mr. Loftin, [fol. 1316] has a totally different significance and means that if an incorrect coupling is used with the quenched spark-gap, a slight mistuning will cause it to quench. This is the condition of affairs which Fig. 3 of the "Electrician" of November 10, 1911, "Defendant's Exhibit C-5" illustrates, and it is the condition which has formed the only technical basis for the contention that the quenched spark-gap circuits must be de-tuned. While this is a condition which can be obtained in the operation of the quenched spark-gap transmitter, it is not the condition which obtains in actual practice, for the simple reason that when the circuits of the quenched spark-gap transmitter are tuned, and the coupling is correct, the results are superior to those obtained when the coupling is incorrect and the circuit slightly mistuned. This latter, which is the adjustment referred to in Mr. Loftin's quotation from Zenneck, merely illustrates the fact that the mis-adjustment of one of the adjustments of a quenched spark-gap transmitter, viz., coupling, can be partially compensated for by another mis-adjustment; a state of affairs quite common in radio circuits, but one which is never employed for the purpose of properly operating the apparatus.

Prof. Fleming, in the paper of "Defendant's Exhibit B-5", referred to by Mr. Loftin, gives merely a brief explanation of some little experience which he has had with the quenched spark-gap, which follows largely the paper by Arco, and which does not contain anything additional to that paper, except the curious statement that when he placed his cymometer alongside of the primary circuit in the quenched spark transmitter, it failed to show any oscillations therein, and he concludes from that that there are no oscillations taking place in this circuit.

There is an obvious mistake of some sort, since it is a fact well-known to every worker in radio, that a wave-meter, which is the ordinarily employed equivalent of Fleming's cymometer, responds very vigorously to the oscillations in the primary circuit, and I have myself made this test very many times.

The mistake in Prof. Fleming's tests is undoubtedly responsible for his statements, such as the following: "excites the free oscillations in the secondary circuit by shock", and I am quite sure that Prof. Fleming's comments along this line would have been quite different had he succeeded in getting his cymometer to work properly when coupled to the primary circuit.

Mr. Loftin, in referring to the second paper by Prof. Fleming in the London "Electrician" of June 11, 1909, "Defendant's Exhibit B-5", entitled "The Utilization of the Total Radiation from an Inductively Coupled Antenna in Radio Telegraphy," quotes the following (Printed Record, p. 1127):

"The primary spark is then quenched with great rapidity and the action upon the secondary or antenna circuit is of the nature of a blow or shock, setting up the free oscillations of the secondary. For this reason this method of excitation is called, in Germany, 'Stosserregung'."

Reference to the paper by Count Arco shows that this statement by Dr. Fleming is somewhat careless, since the following appears in the Arco paper:

[fol. 1317] "When, however, the idea of the 'Stosserregung' is taken up, these six half

Fig. 2.

oscillations have to be combined into one blow. Zenneck defines a good sender for 'Stosserregung' by saying that the oscillations in the primary system must be quenched after the first period and after the primary system has given up all its energy to the secondary system. For this reason the Wien arrangement belongs naturally to this class; but in spite of this there arises the question whether it could be called a 'Stosserregung' pure and simple. The arc lamp with a large primary condenser is much more a 'Stosserregung', as the quenching can be obtained after the second half oscillations, and tuning between the two circuits is hardly necessary."

This quotation indicates that even Count Arco, who was the technical head of the Telefunken Company, was not prepared to assert that the quenched spark-gap system employed by his Company, was capable of functioning on a

shock-excitation basis. In fact, it brings out that he considered another arrangement, viz., an arc lamp with a large primary condenser, as being much more a shock excitation device.

I have already discussed Fig. 3 of the "Electrician" of November 10, 1911, and I note that, in referring to this exhibit ("Defendant's Exhibit C-5"), that Mr. Loftin has quoted the following statement (P. R., p. 1128):

"To give the best result it is necessary that the reaction of the secondary circuit should assist the quenching in the primary, and for the reason the two circuits are slightly mistuned, namely, to the extent of about 2 per cent. The closer the coupling the greater must be the mistuning."

This is a statement in words of the facts disclosed in Fig. 3 of this exhibit, and which is based on the action of the quenched spark-gap when an incorrect coupling is used.

While the technical facts which form the basis for this statement are contained in Zenneck's book, I consider it very significant that his book contains no statement of the sort just quoted, and to the effect that this is a necessary adjustment.

It is also significant that this statement, which refers to a possible, but inferior, adjustment as being the necessary adjustment, is not made over the signature of any recognized radio authority.

The Seibt patent, No. 1,216,615, "Defendant's Exhibit C-3", cited by Mr. Loftin on pages 1128 and 1129 of the Printed Record, in answer to Q. 35, has already been discussed in answer to Q. 199 of my deposition, and various statements from the File Wrapper and Contents quoted. One of these statements at this point seems sufficient to again call attention to the fact that Seibt considered that his invention employed the disclosures of the Marconi patent 763,772, and is as follows:

"* * * * * Wien did not disclose what applicant discloses—namely, means for producing powerful slowly damped free oscillations in the secondary circuit. In order [fol. 1318] to accomplish this result, which turned applicant's invention from a laboratory experiment into a practical, useful and commercial device, applicant brought the two oscillating circuits in tune with each other, coupled them in the manner described, employed a very short spark-

gap having electrodes of high thermal conductivity and used a source of electrical current having a potential capable of quickly effecting a disruptive discharge across the spark-gap." ("Claimant's Exhibit No. 245.")

Mr. Loftin next takes up Zenneck's book of "Wireless Telegraphy" and, among other things, cites a quotation, which I have already answered, relative to the slight detuning. I note, however, that he does not include the quotation from this same book and, in fact, the same page, which distinctly specifies that the circuits shall be tuned for best operation. He also refers, at the bottom of Printed Record, page 1129, to the similarity between Zenneck's language and that of Lodge in his 1898 patent. It seems sufficient to point out that, as I have already shown in answer to a previous question, while language may be employed by technical writers which is similar to that in the Lodge 1898 patent, and intended to be descriptive of the action of the quenched gap, this similarity ceases when we step from the language of statements to the facts disclosed by actual operation.

Mr. Loftin also refers to Fig. 132, page 94 of Zenneck's book, and the photograph there of oscillations in a quenched-gap circuit. It would be interesting to see an Engineer attempt to build a quenched spark-gap transmitter from the information contained in the Rau article, from which Fig. 132 is taken, and which purports to be an illustration of the action in a quenched spark-gap transmitter.

In so far as any information in that article is concerned, I find it entirely impossible to form any intelligent idea as to the nature of the supposed quenched spark-gap employed for the test, and therefore consider it to be worthless.

Mr. Loftin next takes up the references to the quenched-spark methods in the book by Eccles, entitled "Wireless Telegraphy and Telephony" 1918 ("Defendant's Exhibit E-5").

The statements referred to by Mr. Loftin are little more than a re-statement of the same remarks found in Fleming's paper, Zenneck's book, Count Arco's paper and the unsigned article of "Defendant's Exhibit C-5", and are very good illustrations of the point which I have already brought out, viz., the habit which technical writers have of including in their work matters which are primarily due to someone else.